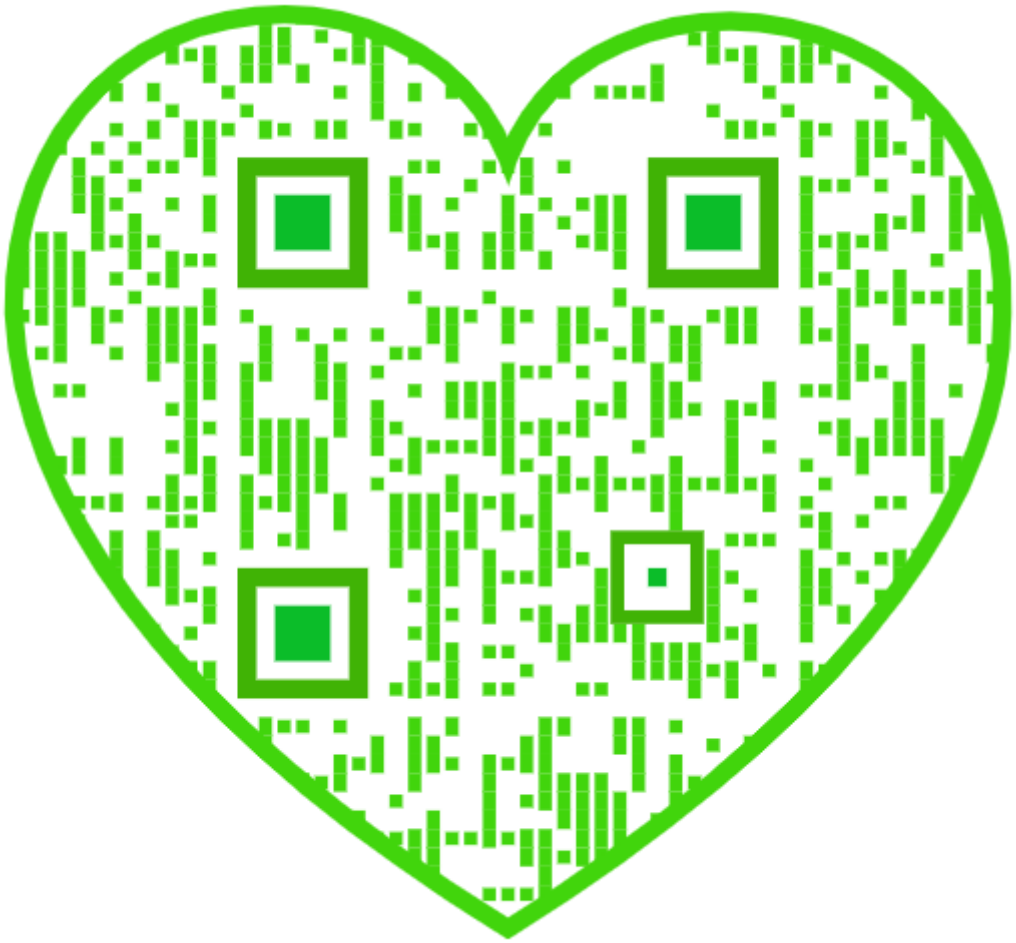
PLANTING IN UGANDA

E·BROWN·F·L·S
H·H·HUNTER·LL·D



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PLANTING IN UGANDA

The first Para Rubber Tree in Uganda
The first Cocoa Tree to the right

PLANTING IN UGANDA

COFFEE—PARA RUBBER—COCOA

BY E. BROWN, F.L.S.
AND
H. H. HUNTER, LL.D.

With Contributions by
PROFESSOR DUNSTAN, C.M.G.
AND
GEORGE MASSEE, F.L.S.

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Personalia:

The Authors—

E. BROWN, F.L.S.

Manager of the Kivuvu (Uganda) Rubber Company Limited, formerly Assistant Botanical, Forestry, and Scientific Department, Uganda

H. H. HUNTER, LL.D.

Director Kivuvu (Uganda) Rubber Company, Ltd.
„ Uganda Plantations, Limited;
„ Buddu Plantations, Limited;
and other Uganda Companies

Introduction by

PROF. DUNSTAN, C.M.G., F.R.S.

Director Imperial Institute, London
President of the International Association for Tropical Agriculture

Chapter on Fungoid Diseases by

GEORGE MASSEE, F.L.S., V.M.H.

Mycologist to the Royal Gardens, Kew

Preface

The need of a reliable book dealing with Uganda has become urgent owing to the recent rapid extension of planting in that country. Some of the planters who now settle there have had large experience of the work in other countries, while others possess no knowledge whatever of the practice of agriculture; but all of them alike suffer from ignorance of the peculiar conditions under which plantations have to be worked in the Uganda region. For their benefit generally, as well as for the information of the large body of investors in the United Kingdom who are now interesting themselves in Uganda properties, this book has been written.

The authors realise the imperfections and incompleteness of the work in many directions; but as some years must elapse before the Uganda plantations are of sufficient age to allow of definite conclusions being arrived at on certain

important points connected with them, it was thought desirable to publish at once all the information and experience gained so far, leaving the outstanding problems to be solved by later experience, and then embody the results in a future edition of the book. Meanwhile they place it before the public as the fruit of a ten years' experience in Uganda.

Their thanks are offered to Professor Dunstan, C.M.G., F.R.S., for his kindness in writing the Introduction, to Mr. G. Massee, F.L.S., for contributing the chapter on Diseases, and to Mr. F. Kaye, A.R.C.SC., for the figures of soil analysis. To the publishers, too, they are deeply grateful for valuable personal help given in the preparation of the work.

The reports of the Botanical, Forestry, and Scientific Department, of the Agricultural Department, and of the Government Entomologist have been consulted by the authors on a variety of points, and always with advantage.

H. H. H.

E. B.

Dublin,

October, 1913.

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The illustrations are all from photographs by E. Brown *and are copyright.*

Introduction

I have been asked by the authors of this book, who are pioneers in the agricultural development of Uganda, to write a few words of introduction to a subject with which the Imperial Institute has been intimately associated.

The success which is now attending agricultural enterprise in the Protectorate has been promoted chiefly through the unremitting work of the small department established by Government, which until its recent enlargement was known as the Scientific and Forestry Department. Its first head was Mr. Alexander Whyte, who was succeeded by Mr. M. T. Dawe, to whose energy and abilities much of the success is due, and of whose staff one of the present authors, Mr. Brown, was a member.

The great possibilities of agriculture in Uganda, referred to in Sir Harry Johnston's standard work, are being rapidly realised. The subject is of exceptional interest, since most of the agricultural districts are at an altitude of 3,000 feet or more.

The remarkable progress shown in Cotton cultivation, which is largely in native hands, owes much to the careful preliminary investigation and guidance of Mr. P. H. Lamb, now of Northern Nigeria, who was the first head of the new Agricultural Department, and his staff, whose efforts were chiefly directed to the establishment of an acclimatised type of Cotton. The Cotton of Uganda is now being grown of a definite grade, and from small beginnings has taken its place among the standard cottons of British commerce. Cotton, however, is so far almost entirely the subject of cultivation by natives, with whom the British Cotton Growing Association have established satisfactory relations.

The annual value of the crop already exceeds a quarter of a million sterling.

The present book embodies the practical experience of the authors principally in the establishment in Uganda of Para Rubber (*Hevea Brasiliensis*), Coffee, and Cocoa, and is mainly intended to guide other planters who are being attracted to the country by the success which has been achieved, by the healthy climate, and by the increased transport and other facilities which are to be provided in the near future with the assistance of the Imperial Government.

The introduction of the Para Rubber Tree to certain districts of Uganda has so far been an unqualified success. The trees have grown well, and for their age have furnished a satisfactory yield of Rubber of good quality. Although the native Rubber tree (*Funtumia elastica*) grows abundantly in the forests and has been the chief source of Uganda Rubber, it now seems certain that in the many districts where the Para tree will

thrive, this exotic tree is destined to become the chief, if not the only, source of Rubber exported from the country. The authors record their own valuable experience in the planting and treatment of this tree.

Coffee, also, has been a great success. Several kinds of Coffee are being grown, but chiefly *Coffea arabica*. The product of Uganda has been well received commercially. Unfortunately the serious news has just arrived of the appearance of Coffee leaf disease. This fungoid disease being indigenous will, it is hoped, be easier to deal with than proved to be the case in Ceylon, where its unfortunate introduction caused vast damage, and finally led to the abandonment of a crop which at one time promised to be the chief agricultural product of the island.

A botanist of great distinction, the late Professor Marshall Ward, was sent out to investigate the nature of the disease, which he did with great thoroughness, but he failed to find a

remedy, and although nearly forty years have elapsed, a means of eradicating this fungus, when once firmly established, has not been discovered. The information given by the authors and by Mr. George Massee in the useful account of fungoid diseases which he contributes to this book, will at least enable the planter to recognise this formidable pest and to arrest its progress. Systematic work with a view to the discovery of a means of eradicating this fungus (*Hemileia Vastatrix*) is one of the pressing needs of tropical agriculture, and the discovery of a fungoid resistant Coffee ought not be beyond the skill of modern Science. The failure of all attempts so far made alone stands in the way of Coffee cultivation in many promising countries.

Cocoa has succeeded in those parts of Uganda in which the climate is suitable, and as these districts are extensive, Uganda bids fair to imitate the example of the Gold Coast, which in

a few years has become one of the chief Cocoa-producing countries of the world.

On many of the views advanced by the authors there will, no doubt, be differences of opinion among tropical agriculturists, but those who are attracted by the agricultural promise of Uganda will find much that is of practical value and guidance in this book. Reference may also be made to the numerous articles on the agricultural resources of Uganda which have appeared in the Bulletin of the Imperial Institute, and especially to that by Mr. P. H. Lamb entitled "Recent Agricultural Developments in Uganda" (vol. x., p. 422).

WYNDHAM R. DUNSTAN.

Imperial Institute,

October, 1913.

Planting in Uganda

CHAPTER I.

Physical Features of the Country

Nature of the Country.—The part of the "Uganda Protectorate" which at present attracts planters is the region lying along the northern and north-western shores of the Victoria Nyanza. Other parts doubtless possess equal or greater natural advantages, but, unlike this, they have not yet been opened up by railways or roads, and so the immigrant fights shy of settling in them. The two provinces comprised in this region are known respectively as the Uganda Province, or Buganda, and the Central Province, or Busoga. Their elevation above the sea-level is about four thousand feet, and the Equator divides their entire area into two almost equal parts.

The two provinces are different in character. Buganda has numerous hills, long and low, and very regularly placed. The hill-tops are only a few hundred feet above the level of the lake; and as the slopes are long they are generally cultivable to the top. The bottom of a valley is usually occupied by a narrow swamp or stream, which in the more rainy districts is fringed with forest. The country, being thus well drained, is admirably suited for the purposes of plantation. Springs are very common : indeed they occur so frequently that one is almost certain anywhere of finding water within a few hundred yards. The whole district is well watered. A stone outcrop often occurs on the hilltop or on the higher slopes. There is generally very little forest land, and no large unbroken forest is to be seen. Busoga differs from Buganda in that its surface is broken only by gentle undulations. Hills being absent, the streams and springs are lacking also, so that the province is very badly watered. A result of this is that there are no forests. Of the two provinces Buganda is the one most favoured from a planter's point of view. At the present time work in Busoga is hampered by the scarcity of local labour.

Long gentle slopes, ideal plantation ground, Kivuvu

Cocoa in a forest glade. Kivuvu

Type of Natural Vegetation.—As stated above, there are few forests throughout the country, and of those that exist none is of any considerable size. Though small, however, they are very dense and luxuriant. They consist of a heavy growth of high timber, intricately matted with large creepers, and surrounded by a dense undergrowth. The planter in selecting his land naturally avoids these little forests, but they are liable to be encroached upon and destroyed by the natives, and it is to be hoped that the Government will take timely and effective steps to secure them against this danger.

The bulk of the land is under a dense growth of "Elephant Grass" (*Pennisetum setosum*). This grass, which forms a compact solid growth effectually killing out all smaller weeds, grows to a height of about 10 feet. It is interspersed here and there with large trees and clumps of bush. The trees are "Muvule" (*Chlorophora excelsa*) and "Mimosa" (*Acacia Spp.*). The bush is very varied, and often thorny.

The grass is burnt off every year in the dry season, which effectually prevents a reversion of the land to forest. The "Elephant Grass" land

will be found to be always well drained and to consist of deep rich soil. Lower land, which is imperfectly drained, will often be found covered with "Lusanke" grass (*Imperata arundinacea*) and a mixture of flowering herbs, or a dense growth of small "Mimosa" with Palms (*Phoenix reclinata*).

Occasional patches, particularly near forest, will be found covered with a growth of "Matovu" (*Acanthus arboreus*). Such soil is usually good.

Hill-tops or upper slopes often support only a low vegetation of fine grasses and small herbs. This is generally due to the shallowness of the soil which covers the underlying rock.

Temperature and Rainfall.—The temperature of the country, although it is on the Equator, is never extreme. The heat is tempered by the great elevation, by an almost continuous light breeze, and by the existence in the neighbourhood of such a large body of water as the Victoria Nyanza. The mean maximum temperature is 80° F., the mean minimum 62° F. There is little variation throughout the year. Breezes are almost continuous during the day, but the air is usually calm at night. The relative humidity is high. The

country is not subject to violent wind storms, although a fairly high wind often precedes rain at the commencement of the wet season. The rainfall over all the country is extraordinarily local. The annual fall over large areas is much the same, but the daily and monthly falls differ for almost every square mile. Occasional abnormal falls of rain occur, particularly at the advent of the rainy season, but, as the figures given in this chapter show, the rainfall is very well distributed, both monthly and daily. As a rule a shower of rain falls somewhat rapidly and the weather clears up quickly, although dull days in the rainy seasons are fairly numerous. At Entebbe, the only place where records of sunshine are kept, the average daily amount of full sunshine through a year was in 1911 six hours. Hail storms occur at rare intervals—not more than once in each year.

The rainfall for the two provinces, Buganda and Busoga, differs very considerably as far as records go. During 1911 records were kept at six stations in Buganda, and at three stations in Busoga with the following result :—

Buganda ...	Mean fall	47.59 ins.	Wet days, 122
Busoga ...	„	„	40.22	„	„	„	93

These figures show a decided advantage in favour of Buganda, not only in the amount of rain, but in its distribution. In some parts of the province, notably in Kyagwe, which is the favourite planting district, the figures are even better. At Kivuvu during 1911 the rainfall was 51·34 ins. spread over 165 days. A glance at the table (pages 8 and 9) will show how even the distribution was.

The year 1911, whose figures we have taken as being the most reliable, was a dry one throughout the Protectorate. At Entebbe, where records have been properly kept over a long period, the average for the last twelve years is 57·78 ins. This, we consider, is about the average annual rainfall for all the territory near the Lake. There are two rainy seasons each year. These have no definite dates of starting or ending. In some years there is no dry period between the two, so that they form one prolonged season of rain. Rarely does a month pass, even in the dry season, without some rain.

The first rainy season may be expected to commence about the middle of March, and continue until the end of June. As to the time of com-

AFRICA
SHOWING
POSITION OF UGANDA
English Miles
MOROCCO
ALGERIA
TRIPOLI
EGYPT
SAHARA OR GREAT DESERT
French Sphere of Influence
NUBIA
ANGLO-EGYPTIAN SUDAN
ABYSSINIA
ITALIAN SOMALILAND
BRITISH EAST AFRICA
GERMAN EAST AFRICA
BELGIAN CONGO
UPPER SENEGAL & NIGER
GULF OF GUINEA
Guinea Coast
LIBERIA
CAMEROONS
BECHUANALAND Protectorate
CAPE OF GOOD HOPE
TRANSVAAL
MADAGASCAR
PERSIA
ARABIA
INDIAN OCEAN
SOUTH ATLANTIC OCEAN
Persian Gulf
Red Sea
Gulf of Aden
Mediterranean Sea
Longitude East 30 from Greenwich

mencement and duration, this is the more reliable season of the two. July, August, and September are more or less dry. Rains commence again in October, and continue until mid-December. From this until the middle of March is the driest season of the year. As we have remarked, however, heavy rains may fall in what are termed the dry seasons. For instance, at Kivuvu this year a rainfall of over 6 inches was recorded in February. The figures of rainfall given, together with the fact of Uganda's great elevation above the sea-level, may lead those who have experience of our crops only in other lands, to believe that Rubber and Cocoa cannot grow in this country at all. These crops indeed would probably not do well at the same elevation in Ceylon or Malaya, but it should be remembered that Uganda is very much nearer the Equator than either of those countries. As regards moisture, we have splendid advantages in the presence of huge lakes to supply moisture to the air, and in a soil exceedingly deep and good, and rich in humus. Further there is the very even distribution of our rainfall. Heavy dews too fall every night almost throughout the year.

That the temperature and rainfall are sufficient

for our needs is amply justified by the actual results recorded in the pages of this book, results which have all been achieved within a short period of time.

The table below gives the figures of mean monthly temperatures and rainfall for a year at four stations in the planting districts :—

Temperature and Rainfall

1911

	ENTEBBE BUGANDA				MASAKA BUGANDA			
	Max. °F	Min. °F	Rain. ins.	Wet Days.	Max. °F	Min. °F	Rain. ins.	Wet Days.
January ...	80	62	2·66	8	82	60	·97	5
February ...	81	62	·26	2	82	60	1·42	4
March ...	79	64	5·98	19	80	60	5·85	10
April ...	76	60	12·38	21	80	60	6·98	22
May ...	77	62	10·86	15	81	60	5·65	19
June ...	77	62	1·34	7	80	60	·86	5
July ...	77	61	2·95	6	81	60	·06	2
August ...	76	61	6·60	7	80	60	1·34	10
September ...	78	62	1·93	7	80	60	3·05	12
October ...	81	62	2·07	8	80	60	3·62	13
November ...	78	62	4·02	14	80	60	4·50	20
December ...	82	64	1·86	6	81	60	·68	8
Means and Totals ...	85	62	52·91	120	81	60	34·98	130

Temperature and Rainfall 1911 (continued)

	KIVUVU BUGANDA				JINJA BUSOGA			
	Max. °F	Min. °F	Rain. ins.	Wet Days.	Max. °F	Min. °F	Rain. ins.	Wet Days.
January ...	90	61	1·45	7	85	61	2·29	5
February ...	89	64	2·22	11	86	63	1·32	2
March ...	87	65	7·53	18	83	64	9·60	17
April ...	76	64	8·45	20	80	64	5·69	18
May ...	76	63	7·71	18	81	63	6·03	14
June ...	76	61	3·92	11	80	62	1·55	8
July ...	75	63	·10	2	81	60	·75	2
August ...	73	63	5·15	14	80	61	3·86	12
September ...	83	61	3·27	16	83	61	1·89	7
October ...	87	62	4·20	18	84	62	5·68	10
November ...	86	63	6·54	22	80	63	10·09	17
December ...	91	61	·80	8	85	62	1·42	6
Means and Totals ...	82	62	51·34	165	82	62	50·17	118

Analyses of Soil.—A typical sample of soil was taken from each of the three principal planting centres, Kyagwe, Busoga, and Buddu, and an exhaustive analysis made by Mr. Frederick Kaye, A.R.C.Sc. His figures are given below :—

	1	2	3
Name of Sample	Kivuvu Kyagwe	Busoga	Buddu
Colour and character of soil.	Red soil of good texture, very free from stones.	Dark red soil of fine texture, almost entirely free from stones.	Darkish grey soil, contains a fair quantity of stones and coarse sand.

Analyses of Soil (continued)

Mechanical Composition.	1	2	3
	Per cent.	Per cent.	Per cent.
Very fine soil passing 120 mesh ...	4·0	4·0	8·0
Fine soil passing 80 ,, ...	0·2	3·4	0·4
Fine soil passing 60 ,, ...	20·0	35·5	15·0
Medium soil passing 20 ,, ...	36·4	51·6	32·4
Coarse sand, etc., ,, 10 ,, ...	22·0	5·2	19·2
Coarse sand and small stones passing ,, ...	11·6	·2	14·0
Small stones	5·8	·1	11·0
	100·0	100·0	100·0
Chemical Composition.			
Moisture	2·290	2·550	1·640
Organic matter and combined water	10·460	9·190	7·960
Oxide of iron	7·010	2·990	4·280
Oxide of alumina	16·160	9·250	9·150
Lime	0·360	0·100	trace
Magnesia	0·090	0·240	trace
Potash	0·133	0·170	0·039
Phosphoric Acid	0·043	0·065	0·041
Soda	trace	trace	trace
Sulphuric Acid	0·039	0·024	0·040
Chlorine	nil	nil	nil
Sand and Silicates	63·400	77·400	76·840
Containing Nitrogen	0·040	0·136	0·0086
,, equal to Ammonia ...	0·048	0·165	0·0104
Acidity	neutral	neutral	faintly acid
Available.			
Citric soluble Potash	0·0380	0·0308	0·0138
Citric soluble Phosphoric Acid ...	0·0118	0·0161	0·0140
Citric soluble Nitrogen	0·0084	0·0098	0·0050
,, equal to Ammonia	0·0102	0·0119	0·0060

The mechanical composition of the soils is excellent, particularly in the case of Busoga, where coarse sand and stones are practically non-existent.

The chemical analyses show a high degree of

fertility. The soils of Kyagwe and Busoga are neutral in acidity, whilst that of Buddu is slightly acid. This is to be expected owing to its paucity of lime.

The chief elements of fertility, iron, lime, magnesia, potash, phosphoric acid and nitrogen are present in sufficient quantities, except in the case of Buddu soil, where lime and magnesia are deficient. In the case of Busoga soil the proportion of magnesia is excessive, while that of lime is less than might be desired.

Both Busoga and Buddu soils, therefore, would be materially improved by the addition of lime. The soil of Busoga is particularly rich in nitrogen. More important, however, than the amount of the elements present in a soil is the condition in which they occur and the quantities immediately available as plant food. Mr. Kaye's Report is specific on these points. His figures have been obtained by treating the minerals with a certain solution of citric acid. The quantity of a mineral which becomes soluble in this solution is considered to be the quantity which is in such a condition as to be readily soluble in the sap of the root-cells of the plant, and therefore immediately available as plant food.

CHAPTER II.

History of Products in Uganda

Dates of Introduction, Origin, Figures of Growth

Rubber.—The Rubber culture was first introduced into Uganda in 1901, when a single tree was received from Kew. This tree was planted on the Lake shore in the Botanic Gardens at Entebbe. The tree in 1904 was 21 feet in height, having made 7 feet of growth each year. The growth of Para rubber was said at that time (*Dawe's Report Scientific and Forestry*, 1904) to afford promise of becoming an important industry.

Early in 1904 the Scientific Department imported from Ceylon 1,000 seeds, from which about 300 plants were obtained. These were in due time planted out in the gardens at Entebbe, where the trees are still to be seen. It is from these trees, which at the end of 1911 were 7 years old, that we are now able to arrive at some conclusions as to

Para Rubber 3 years old. Botanic Gardens, Entebbe

Para Rubber 4 years old. Botanic Gardens, Entebbe

growth and yield. Unfortunately the first tree introduced was blown down in 1910, so that its record of growth and yield, which might have extended our knowledge three years further, is of no service.

From reports published by the Botanical and Forestry Department, we are able to obtain the following figures relative to the trees just referred to :—

Date sown	early 1904	Height	Girth at 3 ft.
Measured	,, 1906	17 ft.	5 inches
,,	,, 1907	22 ,,	8 ,,
,,	,, 1908	25 ,,	12½ ,,
,,	,, 1309	33 ,,	15½ ,,
,, Average of whole field	,, 1912	—	22½ ,,

These figures show that the tappable size, *i.e.*, 16 inches girth at 3 feet from the ground, is reached in five years from the time of sowing in Uganda. This is further borne out by an examination of the results obtained in fairly extensive plantations on the Kivuvu estate; and results given in a later chapter prove that tapping at five years is quite a success commercially, and in no way injures the trees if properly carried out.

Other introductions of seed from Ceylon and

Malaya have since been made by individual planters.

Cocoa.—The first plantings of Cocoa were made in 1901 in Entebbe Botanic Gardens, the young plants in this instance also having been brought from Kew. We read* that they were planted, half of them in heavily shaded forest, and half in a more open situation. The latter were found to thrive much better than the former. The general result is said to have been very satisfactory.

In the report of the Scientific Department for 1905 we learn that during the previous year the Cocoa crop made very little progress; but a year later the report of the same Department told of immense improvement in the condition of the trees, which improvement it attributed to systematic pruning. From that time onwards the crop improved yearly, until now its success in Uganda is assured. Experience has shown that great care is required in the early years of the tree, but given such care, especially a proper amount of attention to the matter of pruning, Cocoa may be planted with a reasonable certainty of proving remunerative.

* Dawe's Report, Scientific and Forestry, Uganda, 1904.

Para Rubber 4 years old. Kivuvu

Para Rubber 4 years old. Kivuvu

The Entebbe Cocoa, planted in 1901, bore a crop in 1906, that is at five years old. Plantations at Kivuvu on a more extensive scale have had a similarly satisfactory result. The whole of the Cocoa in Uganda has come from the Entebbe trees and their progeny.

Coffee.—Two varieties of *Coffea arabica* are grown in the country, namely, "Nyassa" and "Bourbon."

The "Nyassa" variety was introduced from Nyassaland to Kampala about 1900 by the late Mr. A. Whyte, at that time head of the Scientific Department in Uganda. There has been no further introduction of "Nyassa" seed, and all the coffee of this kind in Uganda is from the original Kampala stock. The "Bourbon" variety was brought in a few years later by the French missionaries, probably from East Africa, where these missionaries had grown it for many years.

Uganda itself had more than one indigenous species of Coffee; and the new kinds quickly showed that they had found congenial conditions. Both varieties grow very rapidly, and produce a first small crop in two-and-a-half years from the time of sowing. The trees may be said to have

arrived at maturity in three years, when they produce a full crop. There are in the forests several kinds of Coffee, or closely allied plants, whilst one species, probably *robusta*, has long been in cultivation amongst the natives.

Cocoa 2 years old in Banana shade. Kivuvu

Cocoa 4 years old. Shade partially removed. Kivuvu

CHAPTER III.

Yields and Results

Age of coming into Bearing.—The time the trees take to reach the productive stage depends on many circumstances : the health of the seedling, the care bestowed on it, the method of planting, the soil, the seasons, and the skill with which the plant is attended to, are all factors which affect the rapidity of growth. Most of these factors are under the complete control of the planter, and it behoves him to see that the plants have every opportunity of developing rapidly. With all the crops we have been considering the productive stage is determined by condition of growth rather than by age; in other words, when the trees reach a certain size they become productive, irrespective of the time they have taken to reach that size. Bad seasons—by which is generally meant in the tropics, dry seasons—are, of course, evils beyond man's power to avert, but even here much can be

done, by good cultivation, to mitigate the effects of drought. Another disadvantage the planter of the past has suffered under, has been the scarcity of seeds and seedlings of Para and Cocoa in the country. Introductions of seeds of these have been made from Ceylon and the West Indies at great expense; and in many cases there has been heavy loss through the failure of these seeds to germinate. The result was that we have been obliged to plant and treasure weak seedlings that we would have been glad to be in a position to discard. The effects of this are visible in the great irregularity of growth in the early plantations, clearly demonstrating how important it is to start with only the strongest and most healthy seedlings. One may see in a field two plants of the same age showing differences of growth which would seem to indicate that they differed in age by as much as two years. Fortunately for the present planter, however, this difficulty is at an end. Seeds are now obtainable locally in sufficient quantities, and at such prices, as to allow of the proper selection of plants, and the rejection of any but the best.

Para.—The adoption of improved methods of

Cocca 4 years old. Shade removed. Kivuvu

Coffee 2½ years old growing between Para.
Kivuvu

tapping the trees, combined with more efficient tools for the purpose, has resulted in earlier tapping being practised than was thought possible a few years ago. It is found that trees with a girth of 16 inches at 3 feet from the ground are capable of giving remunerative returns, by light tapping which causes no injury, and does not retard growth. This stage is reached in five years in Uganda. A fairly large number of trees of this age were tapped at Kivuvu last year. The appearance they presented after several months' tapping, and the rate at which new bark was being formed, proved that no injury had been inflicted by the operation.

Cocoa.—Our Cocoa produces its first perfect pods in the fifth year after sowing. The pods are few in number and often small. It can hardly be said that bearing commences until the trees are five years old. From that time forth the crops should be remunerative.

Coffee.—This tree yields its first crop in two-and-a-half years after sowing. This, which is called the "maiden" crop, is usually about half the amount of a full crop. Its next crop, the first full one, is produced in three years. In Ceylon the

Coffee tree commences to bear when five years old.

Seasons of Crop.—The crop season naturally depends on the rains; it may be early or late according to the time at which these fall.

Para.—This tree may be tapped soon after the commencement of the March rains, and the tapping continued up to the end of December, with a possible break of a week or two in July, should that season prove very dry. The tapping should cease at the end of December. We thus get from eight to nine tapping months in the year; and if the work is carefully done, due economy of the bark being practised, the trees may be tapped for the whole of this period without injury.

Cocoa.—The flowering season starts in February and continues almost throughout the year. The setting of the fruits is, however, more seasonal, for the picking season extends only from August to December. From the fertilisation of the flower to the ripening of the pod the period is from five to six months, so that fertilisation takes place only in the period from March to July. A considerable number of young pods wither and fall off after having swollen to one-and-a-half inches in length. This, however, need cause no alarm; it is probably

Coffee 3 years old in fruit. Kivuvu

Coffee 3 years old in flower and fruit. Kivuvu

Para Rubber 5 years old. Botanic Gardens, Entebbe

due to the inability of the tree to perfect all the pods it bears: a portion of the work had to be shirked that the remainder might be well done.

Coffee.—In Uganda a Coffee plantation yields two main crops each year. There are, however, intermediate flowerings, so that on an estate some picking is in progress every month from February to November. The largest flowering takes place in February, and the resultant crop commences to ripen in September. The second flowering takes place in August, and the crop commences to ripen in March. The period between flowering and ripening is about eight months. It will be noticed that in both seasons the flowering takes place just before the ripening of the previous crop, and just before the rainy season.

The trees at the time of flowering produce blossoms on all the mature growth, and therefore the amount of each crop depends upon the amount of growth made by the tree since the previous flowering. The heavier the crop carried by a tree in any season the less will be its growth, and the smaller its crop the following season; but in the third season the crop will again be large. There is thus one big crop and one small one each year.

The flowers will remain in the bud stage for a considerable time if no rain occurs to cause them to expand. The berries too will not ripen until rain comes. It will be seen that in this way a crop may be hastened or retarded to a very large extent by the weather. In practice we find that this is so to such an extent as to render it impossible to predict in what month the crop will be harvested. It frequently happens that on two estates situated only a few miles from each other crops may vary in time of ripening by as much as two months.

YIELDS.—Our records of yields of Para and Cocoa are, it is to be regretted, rather fragmentary; but this is only to be expected, considering the very short time the trees have been in cultivation in the country. Records of yields will now rapidly accumulate, but meanwhile it may be useful to set down all we have at present obtained. The records that have been secured make very promising reading, and augur well for future success. With Coffee we have well passed the pioneer stage, and we can give reliable figures of yields obtained in the field on a very considerable scale.

Para.—The first tapping experiment in Uganda

Cocoa. A crop at 5 years, unshaded. Kivuvu

was commenced on November 14th, 1908, at Entebbe, when a seven-year-old and a four-year-old tree were operated on. Tapping was continued over a period of 59 days. The yields obtained were, in dry rubber, 4·7 ozs. from the seven-year-old tree, and 4·3 ozs. from the four-year-old tree. It was estimated from the above yields that 1 lb. of dry rubber, per tree, per annum, could be expected. It should be explained that the seven-year-old tree was the original tree introduced from Kew, whereas the other was from a home-grown seedling. Further experiments were made on four-year-old trees, which, for 44 tappings over a period of 90 days, yielded $4\frac{1}{2}$ ozs. of dry rubber each; and in a later experiment still the same trees yielded $5\frac{1}{2}$ ozs. of dry rubber each in a period of 60 days.

During 1912, also at Entebbe, 164 trees were tapped 41 times over a period of three months. The yield obtained was 13 ozs. of dry rubber per tree. In the report giving these figures the age of the trees is not given; but presumably they are the trees which were four years old in 1908, and their age at the time of this tapping was eight years. The methods of tapping were varied and experi-

mental, but what particularly interests us just now is actual results obtained.

Further figures, which are more valuable as arising from a larger experiment, were obtained last year at Kivuvu by the writers. The tapping here was carried out on commercial lines. On an average 1,800 trees per month were tapped for four months. The yield in dry rubber was 5·13 ozs. for that period. The trees were five years old. The method of tapping was one basal V-cut.

The following table summarises these figures and gives the yield per annum calculated on the supposition that the trees would yield at the same rate for eight months in the year :—

Experiment.	Age of Tree.	Area tapped.	Yield in ozs.
1	4 years	6 ft. of stem	18
2	4 ,,	do.	12
3	5 ,,	do.	22
4	8 ,,	do.	35
Kivuvu	5 ,,	18 ins. of stem	$10\frac{1}{4}$

It will be noted that whilst 6 feet of stem was tapped in the Entebbe experiments, only one quarter of that area was worked at Kivuvu. In the latter case the tapping was very light; in the

Coffee 5 years old. Nsambya Mission, Kampala

former it would be considered by many too severe on such young trees. Further, it should not be forgotten that in the case of the Entebbe experiments only a few trees were tapped, whereas at Kivuvu the number was 1,800. Figures obtained in experiments on a small scale are rarely borne out by a more extended experience. This arises from the impossibility of bestowing as close attention on the work in the latter case as in the former. The general conclusion, however, to be drawn from the figures is that nearly 1 lb. of rubber may be obtained from a five-year-old tree, and 2 lbs. from an eight-year-old tree. These results are entirely satisfactory.

Cocoa.—With Cocoa we have even fewer actual figures of yields on record than in the case of Para. Trees have been yielding in Entebbe Botanic Gardens for the last six years, but no records of these yields have been published. All the crop has gone for seed, for which the demand is very great. One cannot but wish that some record of the number of pods gathered had been kept, for from such figures a fairly accurate estimate of the crop could have been made.

To convey an idea of what a good crop of Cocoa

is considered to be in Trinidad, we give the following figures from " Cacao " by Hart :—

A scanty crop	...	0.82 lbs. per tree	=	9 pods.
Average crop	...	1.65 „ „ „	=	18 „
Good crop	...	2.47 „ „ „	=	27 „
Superior crop	...	3.30 „ „ „	=	36 „

The number of pods, which we ourselves have added, is calculated on the basis of 11 pods to 1 lb. of dry Cocoa. This is the average figure for Ceylon and the West Indies.

We have, here in Uganda, frequently counted up to 100 pods on a tree, and 36 is a common number, so that there can be little doubt that our yields will come up to the good yields in Trinidad. We have taken as many as 95 pods from a single tree at one picking. Allowing for our pods being smaller, this represents a yield of dry Cocoa considerably greater than what would be termed a superior crop in Trinidad. Although we are not in a position to give actual yields in figures, still we consider our experience justifies us in saying that a five-year-old tree in Uganda may be relied on to give 1 lb. of dry Cocoa, with substantial increases each year until maturity is reached.

Coffee 5 years old between Para. Nsambya Mission, Kampala

Such yields must be considered satisfactory, and they will make Cocoa plantations as remunerative in our country as they have proved elsewhere.

Coffee.—In 1905 a Coffee plantation in the Botanic Gardens at Entebbe produced its first two crops. One ripened in May and the other in October. The yield of Coffee in parchment for the year was 2 lbs. per tree.

At Kivuvu during 1912 39,940 trees were cropped. These produced 73,134 lbs. of parchment Coffee. Of the trees, 26,818 gave a full crop, averaging about $2\frac{1}{2}$ lbs. per tree, and 13,122 gave the "maiden," or half crop, which averaged about $\frac{3}{4}$ lb. per tree. Results averaged over such a large number of trees are conclusive and may therefore be safely taken as the basis for estimates for a plantation of any size. The figures confirmed similar ones obtained during the previous year on a smaller area. They indicate a yield of $2\frac{1}{2}$ lbs. Coffee in parchment, which will give exactly 2 lbs. of cleaned, saleable Coffee. In the palmy days of Coffee in Ceylon we read of a yield of 1 lb. per tree being considered good. Our yields, therefore, are calculated to make us sanguine as to the prospects of the Coffee growing industry in Uganda.

Prices Obtained.—*Coffee.*—On page 33 we give a table showing prices received for Kivuvu Coffee in the London market over a period of one year. The variation in prices of the different grades depends on the relations of supply to demand. The cleaners in London have a knowledge of the demand of the day, and are able to grade accordingly. In Uganda we cannot do this, but must always grade to standard sizes. This is, to our mind, the strongest argument which has been brought forward in favour of London cleaning. The difference in price between London and Uganda cleaned, it will be noted, is not great. It no more than covers the extra cost of shipping parchment and of cleaning in London.

The high value placed by the buyers on artificially-dried Coffee is particularly gratifying. There were not wanting in Uganda the usual prophecies of disaster following this innovation. Machine-drying, however, had to come if we were to grow large quantities of Coffee, and the fact that Coffee so dried is considered not only equal, but superior, to that which has been sun-dried, is very much in our favour. We believe the prices we record will be considered entirely satisfactory.

Para field 5 years old. Kivuvu

Uganda Coffee is now known in London. It is classed as a high-grade Coffee, and doubtless when larger and more regular shipments are received, it will be even more in demand. It is sincerely to be hoped that every planter will endeavour to keep up the reputation of our produce, and that pressure will be brought to bear on native growers to prevent them from injuring it in any way.

Para.—No sales of Rubber on a commercial scale have yet taken place, so that we are entirely dependent on valuations for our money figures relating to this commodity. The results of the valuation of a sample from Uganda are given in the report of the Botanical, Forestry and Scientific Department, 1912. This examination was made by the Imperial Institute. It reads :—

Number of Mark—No. 1 Para Crepe.
Weight of Sample—1¾ lbs.

Description.—Clean brown rubber in the form of thick crepe or corrugated sheet ; dry, well-prepared, and having a slight smoky odour. The rubber was soft and weak, comparing very unfavourably in strength with average plantation Para.

Results of Examination.—Loss on washing (moisture and impurities), ·06 per cent.

Composition of dry-washed rubber:—

Caoutchouc	per cent.	94·0
Resin	,,	2·7
Proteids	,,	2·9
Ash	,,	0·4

Commercial Valuation.—About 4s. 8d. per lb. in London, with fine, hard Para at 4s. 4½d. per lb., and "medium" to palish plantation crepe at 4s. 9d. to 5s. 0½d. per lb.

Remarks.—This rubber is very satisfactory in composition, being quite equal in this respect to plantation Para rubber from the East, but it is deficient in strength. This defect is probably due to the rubber having been obtained from young trees, and there is little doubt that the product furnished by the trees as they become older will show a great improvement in physical properties. The rubber will then be of greater value.

The weakness of Rubber from young trees is a question which continually crops up in connection with plantation Rubber. It is only reasonable to expect that the strength of the Rubber is affected by the age of the tree producing it. The defect is one which only time can remedy. Meanwhile we can regard with satisfaction the fact that our Rubber can be made of such quality as to reach a value almost equal to that of the Rubber from the East.

Cocoa.—Here again there are no actual sales to record. As explained elsewhere, all our Cocoa to

date has been in demand for seed purposes. A sample of a few pounds was prepared at Kivuvu recently, and forwarded to London for examination. The report reads :—

We have received from the Manager in Uganda two samples of Cocoa, and beg to hand you herewith report on same, and valuations.

The larger grade we will, for convenience, refer to as sample "A" and the smaller as sample "B."

Sample "A" represents a fairly bold, bright, pale reddish cocoa. The fracture is good, but rather too dark. Light and pale-breaking descriptions fetch the best prices. Compared with prices ruling for Ceylon and Java sorts, it is worth 75s. to 77s. per cwt.

Sample "B" represents a small and lean cocoa of the same appearance as above, and is worth about 56s. to 58s. per cwt.

If "A" and "B" grades were mixed together, the value would be about 65s. per cwt.

The cocoa is very good in appearance, and has been well prepared and cured, but it appears to have been too violently dried, which may account for the black marks on some of the beans, also the shrivelling of the shell. Probably the number of small beans are due to immaturity of the trees.

To get the best results, the cocoa should, we think, be graded into three sizes. The first size to consist of bright and pale and boldest, free from defective and discoloured beans. The second size of medium, and to be as even as possible as regards colour and size. The third size should include the lean and small. Broken cocoa should be kept separate ; also the quite black beans.

Great care should be taken in the drying, the heat should not be too great, and the cocoa should be allowed to dry slowly. In any case, the lean and badly discoloured beans should be picked out.

Signed for Crichton and Co.,
London.

It will be gathered from this report that the sample was by no means a picked one. It represented, in fact, every bean the pods contained. It should also be recorded that the pods were taken at the end of the crop season, when they are usually in size below the average.

The report indicates defects of preparation which will naturally disappear when we become more experienced in the art of curing and drying. Then, with proper grading, we can expect remunerative prices for our Cocoa.

Prices realised for Coffee from Kivuvu, per cwt.

Date of Sale.	Peaberry.	Bold Size.	Medium.	Triage & Smalls	Remarks.	
1. Sept. 6, 1911.	81/-	82/-	80/6	75/-	Cleaned in Uganda.	
2. Nov. 9, 1911.	77/6	77/-	76/-	74/6	Cleaned in Uganda	Consignment sea damaged.
3. Jan. 17, 1912.	80/-	80/-	76/6	76/-	Cleaned in Uganda	Both sold on same day.
4. Jan. 17, 1912.	83/-	82/-	79/6	76/6	Cleaned in London	
5. May 1, 1912.	82/6	80/6	79/-	77/-	Cleaned in London.	
6. Sept. 16, 1912.	83/6	83/-	80/6	79/-	Cleaned in London.	Sun-dried.
7. Sept. 16, 1912.	84/6	83/6	80/6	78/-	Cleaned in London.	Machine-dried.
8. Oct. 14, 1912.	85/6	82/6	80/-	77/-	Cleaned in London.	Machine-dried.
9. May 1, 1913.	79/6	80/-	76/-	60/-	Cleaned in London.	Sun-dried.

Compare Nos. 3 and 4 to see the increased price received for London cleaned.
Compare Nos. 6 and 7 to see the difference in price for artificially dried.
In each case sale took place on same day.

CHAPTER IV.

Probable Life of Tree, and how to prolong it

In the case of plantations such as we are considering, which take several years to bring to the bearing stage, the number of years that the tree will continue to bear remunerative crops is an all-important consideration. The treatment accorded the tree and the crop it is allowed to bear must be regulated in such a way that the best results for the period of the tree's life is obtained. Whether in all cases it is possible or advisable to endeavour to extend the life of the tree by expensive treatment, such as pruning, is a matter for each individual planter to decide for himself.

As regards the plants we have been considering, it must be borne in mind that unless the requisite degree of good growth is maintained year by year, the tree is suffering in some way, and its life is being shortened. This can happen through bad cultivation. It can also happen through over-

cropping. With Para and Cocoa cropping can be easily controlled, but with Coffee it is rather different.

Para.—The cropping of Para is the extraction of latex from the tree, and necessitates wounding the bark. Tapping must, therefore, be carried on only to such an extent that it does not interfere with the normal growth and development of the tree. A system of light tapping which can be practised on young trees has been discussed in another chapter, but it may be stated here that the effect of tapping should be very closely watched. Care must always be taken not to tap too deeply lest the cambium layer of the tree be injured, and also to secure that the removal of bark by paring is not too rapid.

When the trees are bare of leaves—a stage known as wintering—and until the new leaves are well grown, tapping should cease. This wintering of the trees corresponds to the fall of the leaf in temperate climates; and the few days it is bare, is the only period of rest the Para tree indulges in. With our young plantations resting is very irregular—some trees rest in one month, and some in another—but as the trees get older this will

alter, and the whole plantation will be found to pass through the resting stage at the same time.

Any effect of over-tapping will be first evident in the condition of the leaves and the growth of the tree, and it should be constantly watched for, so that at the slightest sign of unhealthy leaf or impaired growth the tapping may be at once stopped.

In Ceylon and Malaya Para trees which have been in cultivation for over 30 years still exist and give large yields of Rubber. True they have not been tapped continuously during this period, but from experience gained during the last 10 years, it is generally agreed that the modern methods of tapping do not in any way injure the trees or retard or weaken their growth. Indeed, when it is seen that trees can develop from the young stage to maturity with continuous tapping, there seems little reason to fear any serious shortening of life from the process. In its native forests the tree is a long lived one, and there is every reason to expect a long life for it in plantations.

Cocoa.—Owing to the habit which the Cocoa tree possesses of casting superfluous pods in a young stage, there seems little danger of over-

cropping taking place, except on poor soil. Young trees commence to flower at three years old, but pods do not form until about the fifth year. From that time, until about the tenth year, a large number of the pods shrivel, and soon after fertilisation they die. In view of this habit the flowering of the trees may be allowed, but if pods form and develop too early they should be removed. It is not wise to rub off the flowers of even young Cocoa trees, as they always occur in indefinite bunches, and an injury to the point of the bunch would result. A good head of foliage with large leaves should be aimed at, and no tree should be allowed to bear a crop unless it possesses these. The quantity of fruit it can ripen without impairing its health depends upon the amount of foliage it carries. Cocoa is a very long-lived tree and has been cultivated in the West Indies for a sufficient time to prove its life as a remunerative crop to be over a century. Sir Daniel Morris writing in 1882 says :—

In their sixth and ninth years the Cocoa trees should be in fair bearing, but they seldom reach their prime before their twelfth or fifteenth year. After this period, where the trees have been carefully established and well cultivated, a Cocoa estate is a comparatively permanent investment, and

it may be expected to continue in bearing and yield remunerative returns for some fifty, eighty, or a hundred years. In fact, if old and exhausted trees are regularly and systematically replaced or "supplied," there is practically no limit to the duration of a Cocoa estate.—Extract from "Cacao," by Hart.

Coffee.—This tree comes under a rather different category to the other two. Of neither Para nor Cocoa does the planter restrict the natural extension of growth to any considerable extent; indeed he rarely makes an effort to restrict it. It is in the nature of the Coffee tree to have only one main stem which produces branches regularly from the base of each leaf as the tree grows upwards, the top branches being always the youngest. As the tree lengthens and branches higher up, the lower branches fall off, the head keeping always about the same size. A growth of this nature is a very inconvenient one for the planter, and he resorts to topping the tree at 6 feet to keep the crop within reach of the pickers. The Coffee tree bears on young mature wood, and never bears a second time over the same area. The portion of the branch which fruits loses all its leaves before ripening the crop, consequently it is necessary for the tree to make an entirely new set of growths each year of equal strength and vigour if the crop

is to be maintained. This is the problem confronting the planter who is desirous of making his Coffee plantation a permanent one. Nature solves it by extension of the axis of the tree with new branches, and discarding the old worn out ones. The planter endeavours to accomplish the same result while preventing any extension of axis, by compelling new branches to spring from the old ones, using year after year the same area of axis which nature uses only once. Such a departure from the natural growth can, of course, only be maintained artificially and by constant interference with the growth of the tree.

The tree bears the first crop on the primary branches for a considerable distance along them. The next crop has then to be borne on the extension of the primary and on secondary branches. By the time the primary branch has borne its second crop it is unduly long, and weak in growth, and it bears very little more. Its place is then taken by one or more secondaries, which in turn are displaced as the bearing branches by tertiaries.

The trees will generally throw out more secondary and tertiary growths than are required to replace the primaries, and if some are removed

it results in the more perfect growth of the remainder. The growths retained should always be those originating nearest the stem of the tree, as this brings the bearing wood back again near the stem. By such a systematic method of pruning with manuring of the soil when it becomes exhausted, there is no doubt that the life of the Coffee tree could be extended indefinitely. The planter has, however, to consider whether it is possible or remunerative to give all this attention to the trees.

Here we ought to remark that there is a decided difference in growth between the two varieties "Nyassa" and "Bourbon." The latter branches much more profusely than the former, and a certain amount of pruning is imperative. With "Nyassa," on the other hand, our experience has been that the vigour of growth is maintained, and the maximum crops are secured, without any pruning, up to the eighth year of the tree. After this age, however, growth becomes weaker, and the trees show every sign of old age.

We have also found pruning a very expensive operation. Once started, it must be continued, as the removal of a few superfluous branches seems

to result in the awakening of all the dormant buds in the tree, causing a denser growth than ever. The vast amount of labour pruning requires renders it impracticable where a large area is in cultivation, for this work will be found to absorb more labour than the weeding and picking operations. There is also the fact to be considered that the pruners must be skilled men. This will prove an enormous difficulty with our labour, which is unskilled, and casual.

All things considered, we believe it will pay best not to prune the Coffee, excepting, of course, "Bourbon," which, as we have said, must be pruned. In dealing with "Nyassa" it appears best to cultivate the crop well, and having got out of it as much as possible, to be prepared to uproot it after it becomes unremunerative, which generally occurs from about the eighth to the twelfth year according to the soil. Land is plentiful in Uganda, and by planting up other areas each year the output can easily be maintained. Young trees will be found more certain in crop and less likely to attacks from pests, than old trees artificially maintained. If, in the meantime, Para has been interplanted, as we have recom-

mended elsewhere, when the Coffee is ready to come out, the land will be fully occupied by rubber trees.

An interesting experiment could be made by cutting down old worn-out Coffee close to the ground, and allowing a new stem to grow up. In our new land it is not exhaustion of the soil which is entirely responsible for the falling off in crop, but merely that the framework of the tree is worn out. Proof of this can be obtained by allowing a worn-out tree to extend its axis a few feet. It will be found to produce a luxuriant head of new branches, equal in vigour to those it produced in its first years of growth, and as fruitful. Possibly cutting down the trees would give them another equal period of fruitfulness, and save the cost of planting elsewhere.

There is a common idea that the early fruiting of our Coffee should be prevented by picking off the first flowers. We have not found any harm result from allowing these to develop. Often the picking off of flowers only induces the trees to flower again the following month. A second lot of flowers does not come on the same part of the branches from which the others were removed. Hence all crop from these is lost.

CHAPTER V.

Choice of Land for Plantations

Choosing Land.—The land best suited for all three crops is gently undulating land. The soil should be good and deep. Steep hillsides should be avoided, as should also swampy and stony land. The water supply must be abundant and permanent. A great deal of water is required for nursery purposes, and later on in the preparation of the products, and it is necessary to make certain that there will be no shortage. In many parts of the country the open land is broken up by belts and patches of forest, and trees skirt the water courses. It is a great advantage to have these natural wind-breaks, and any felling of timber therein should be cautiously carried out. The entire clearing of any of these small forests will often result in the water supply of the estate being seriously diminished.

To all the crops strong winds are detrimental,

and particularly so to Cocoa. It is essential that naturally sheltered sites be selected for this crop : the glades between patches of forest are ideal for the purpose. For Rubber and Coffee artificial wind-breaks can be formed where a natural protection does not exist.

Another point which should be considered when choosing land is its healthiness; and a hill on the estate, removed from swamps, and suitable for residential sites for an European staff is a practical necessity. Also, it must be remembered that native labour is essential, so that unless there is a certainty that native workers can be brought from a distance one should not think of beginning a plantation in a sparsely populated district.

Transport Facilities.—Probably this is the most vital point of all to be considered in deciding where the plantation shall be. There are undoubtedly large areas of excellent land, in districts where labour is most abundant, but which are too far from rail or steamer to be of any present use to the planter. In the running of an estate a very large amount of transport is necessary. Machinery and stores have to be brought in, and produce carried out. Estates within a reasonable distance of the

railway or steamers have a very great advantage, for although roads exist to many more remote parts of the country, they are totally unfit for the heavy traffic of the planter. Wheeled transport is, of course, necessary, but draught animals in Uganda being weak and subject to many diseases, the only feasible plan of shifting large quantities of produce is by the use of mechanical transport. Probably in time light railways and good roads will be made to connect up the large fertile areas of the country, but until this is done the planter will find transport one of his greatest difficulties, should he be situated at any distance inland.

Indications of Natural Vegetation.—As a general rule a very accurate idea of the character of a soil, as well as of the rainfall of a district, may be gathered by a careful examination of the wild growth it supports. In a tropical country the vegetation will be naturally luxuriant unless there is some factor such as poor soil or insufficient rainfall operating against it. Where the natural vegetation is scanty the planter should endeavour to discover the cause, for it is almost certain that the crops he plants will also be affected by this cause.

The existence of a high growth of "Elephant Grass" is a certain indication of a deep rich soil, well drained. The prevalence of patches and strips of forest denotes a well-watered district with a good rainfall. The districts of short grass, interspersed with brush and small trees, should be regarded with suspicion. Here, either the soil is for a part of the year sour and swampy, or the rainfall is deficient. Land supporting short, fine grass only will generally be found to consist of a shallow soil overlying rock.

In some cases the cause of a scanty vegetation can be traced to recent native cultivation. Abandoned native gardens are often full of couch grass and other pernicious weeds, and entail great expense in cleaning.

The best land of all is undoubtedly virgin forest, but this being difficult to obtain, and expensive to clear, need not be considered. The next best is that growing "Elephant Grass." Provided one is assured that the rainfall of the district is satisfactory, one can safely choose this kind of land for the cultivation of Rubber, Coffee, and Cocoa.

In another chapter chemical and mechanical analyses of typical Uganda soils are given. Valu-

able as a chemical examination is, there is no doubt that, as a test of suitability, experiments with the plant itself are very much better. The prospective planter should endeavour to see all he can of similar crops growing in his immediate neighbourhood.

CHAPTER VI.

Nurseries

Propagation.—With all three plants propagation by seed is the quickest and easiest method. Cuttings of Para and Coffee may be rooted, but the process is slow and uncertain at the best, and scarcely practicable at all on a large scale. Coffee seeds germinate in about 50 days, Para in 21 days, and Cocoa in 14 days. As Cocoa and Para seeds quickly lose their vitality, they should be sown as soon as obtained. Coffee seed can safely be kept several months if dried naturally and slowly. Half dry coffee seed will germinate more quickly than either quite new or quite dry seed. A pound of dry coffee seeds contains 2,500 seeds.

The grafting method is receiving great attention from Cocoa growers in the West Indies and other countries, and is found to be a sure way of propagating an absolutely pure stock. Cocoa cross-fertilises very readily, therefore a stock propa-

gated by seed cannot be kept true. The Cocoa at present in Uganda is of a very mixed nature, but this is not altogether a disadvantage, as in the present early stage it is impossible to say which kind may prove most profitable. Having so many varieties we shall have an opportunity of picking out the kinds best suited to our climate. Until we have reached this stage of discrimination, any attempt at selection of seed is not likely to be useful. Already we can see that certain varieties come into bearing much earlier than others, but then we cannot be certain that those which bear best in the very young stage will bear the largest crop eventually.

Beds.—The site for the beds should be carefully chosen. It should be as near as possible to a good water supply, but a low badly-drained situation should be avoided. The soil should be of the best. The proximity of the site to the field to be planted should also be considered, with a view to saving labour in carrying the plants. The site of the nursery need not be chosen with a view to permanence; a new one may be made for each field to be planted if that is found necessary.

The beds should run down the slope, and in the

direction of the water. To facilitate attention they ought not to exceed five feet in width. It is, however, not advisable to have them much narrower than this, or water will drain away too rapidly from them. Each bed should be separated from the next by a trench about 9 inches deep, the soil dug out in forming this being used to raise the bed. The trench serves the purpose of a drain to the bed, and also as a path. For the latter purpose a width of at least eighteen inches will be necessary.

The beds when formed should be forked over to a depth of 1 foot, in order to reduce the soil to a fine state. All stones and roots must be removed. The beds are now ready to receive the seeds, and the next step is to erect a frame to carry the shading. It will be found advisable to make this of good stout posts which will last for several seasons if required. The actual shading material, consisting of palm leaves or grass, can be put on or removed as required, without interference with the frame-work. We prefer each bed to be shaded independently, rather than have one frame erected to cover many beds. There are several reasons for this. Under a large roof the plants receive less air

Making pots of the Banana leaf stalk. Kivuvu

and light than when the roof is interrupted at each bed. The covering too can be placed much lower when it is not necessary—as it will not be when each bed has its separate shading—to go about underneath it; and the danger of its being blown down on the plants is thus avoided. Further, the separate system allows the sun to reach the paths between the beds, and so keeps them dry and clean for use.

A different treatment in the nursery is necessary for the three plants.

Cocoa.—We have found it advisable to sow the seeds fairly close together, in beds one inch deep, and transplant them into pots or baskets as soon as they germinate. The seeds may indeed be sown in pots—one in each pot—in the first instance, but the method of sowing first in beds is more advantageous, as in the subsequent potting any weak seedlings can be at once discarded. The least possible check results to the plant when the potting is done as soon as germination takes place and before any leaves are produced. The root of the young plant is then short, and if it is carefully lifted with the aid of a trowel it will not be damaged in the slightest. The pot should be

previously prepared by half-filling it with soil, firmly pressed down, and then loosely filling it to the top. A hole larger and deeper than the root being then made in the middle, the plant is placed in it, and the soil well pressed down all round. The soil should not come up to within less than an inch of the rim of the pot, as this space is required for water. The points to be carefully insisted on are that the root of the plant is straight down in the pot, and that the soil is in contact with it, that the plant is buried only to the same depth as that at which it was growing in the bed, and that the whole of the soil in the pot is uniformly firm.

The pots are then placed standing close together in rows across the bed. Each row should consist of 10 plants, and a small space had better be left between each 10 rows to facilitate the checking of the number of plants. The plants remain in these pots until ready for planting, which may be at any time after they have reached the age of four months. They must be well shaded all through, and potting operations must also be carried on under shade.

In watering these plants, or in fact any plants

in pots, the rose should be removed from the watering pot so that the waterer may be in a position to pass over any plants not requiring water and to fill the pots of those requiring it. The plant requires either a good soaking of water or none at all, and if this be borne in mind in doing the work, the plants will be found to grow very much better than if watering were done regularly and indiscriminately over the whole batch, without regard to the wants of individual plants.

Para Rubber.—This plant may, we think, be best treated up to the potting stage in a similar way to that outlined for Cocoa. As soon as it is established in the pot it may be given less and less shade, until finally it is allowed the full benefit of the sun. In the long dry season, however, a slight shade may be given to lessen the need of water. The plants grown under this treatment may be planted out in the field at 6 months old.

Some planters leave the young Para in the seed beds until it reaches a large size. They then cut it back or stump it before planting. This method saves a good deal of trouble, and proves very successful in a good rainy season. It is the best plan, therefore, to adopt, if regular rains can be

depended on, after planting until the stumps have made root. By it the plants can be kept in the nurseries until two years old; and although they have to be cut back to 1 foot in height, and the tap root also cut off, the growth they afterwards make is very robust and rapid. Our experience, however, is very much in favour of the pot system for Uganda, as owing to the irregularity of our rains, establishment in the field is much more certain. The only drawback is that the pots will not support the plants for a longer period than about six months without renewing.

If it is intended to allow the Para to grow on in the seed beds the seeds should be grown not less than one foot apart.

Coffee.—The seeds should be sown half-an-inch deep and be shaded and kept moist until germination has taken place. They can be sown 6 inches apart in the beds where they are to grow until large enough for planting in the field. A practice we recommend, however, where large numbers have to be raised, is to sow the seeds very thickly in a bed, and, when germinated, but before the cotyledons unfold, to prick them out into other beds at the required distance. By this method the water-

Coffee Nursery. Grown entirely without shade Kivuvu

ing of many beds during the two months of germination is saved, and if the young seedlings are carefully handled they show no sign of a check in growth.

When the young plants are established the less shade given the better. Shading is not at all necessary for Coffee, but can be resorted to in the dry season to save watering. All shading should be removed a few weeks before the plants are removed into the field, in order that they may be hardened to the sun. Coffee plants are large enough to plant out at any time after the age of eight months old. Potting is not necessary in their case as in that of Cocoa and Para.

By sowing during the rainy season we have frequently raised large numbers of plants without the use of shade or water at any stage. Such plants are found to stand transplanting to the field very much better than those which have been shaded and regularly watered.

The nursery should in every case be large enough to afford supplies considerably in advance of what is expected to be necessary for the purposes of the new plantation. Some new plants will be required in every field, and should therefore be available.

It is a great advantage to be able to discard weak or inferior plants. At least 50 per cent. then over the estimated requirement should be grown in the nursery. Any plants remaining over after the planting should receive attention that they may keep pace in growth with those in the field. In this way a supply to meet all contingencies is secured. It is advantageous after planting a coffee field to put a few thousands of similarly sized plants in pots. These can then be used later on for vacancies, and can safely be planted even at times when there is but little rain.

The regularity of the growth greatly improves a field's appearance, as well as adding to its yield, and it is in the nursery, as we have pointed out, that this must be provided for.

CHAPTER VII.

Laying Out Plantation

Roads.—The plan to be adopted in laying out the plantation must depend upon the nature of the land to be dealt with. Given land fairly level, or sloping gently, the easiest plan is to cut it up into square blocks by main and secondary roads, leaving each block of a given acreage.

If this is to be the plan, a main road should first be made from the site of permanent water—where a factory can be erected—right up to the farthest portion of the estate, so as to cut the whole field into halves. This main road should be at least 30 feet in width. If the area to be planted is very large, or of such a shape that one main road will not sufficiently open it up, two or more such roads may be made. It is advisable to consider well beforehand the plan to be adopted, as once the roads are made and the planting done, no altera-

tion can be carried out without much labour and the destruction of many trees.

From the main road other roads should run at right angles, and again from these others also at right angles, so as to cut up the area into square blocks. The secondary and other roads may be made narrower than the main one; 18 feet will be ample width. The blocks should not be less than 20 or 30 acres each in extent, or the proportion of roads to the planted area will be excessive.

It will be obvious that if this plan of laying out the estate be adopted on more or less hilly land, many of the roads will run up and down, with gradients inconvenient for the use of carts. As most estates in Uganda are too irregular in surface, it is necessary therefore to adopt a different arrangement. This is to make roads wherever they are required, and to run them according to the contour of the hills.

In opening up an estate in this way, it is necessary first of all to decide on the site for the factory. All roads should then run either to this point, or into other roads which reach it, and as the factory site must always be near permanent water, and therefore near the lowest part of the

Coffee 4 years old in fruit, growing between Para. Kivuvu

estate, it can often be arranged that all these roads shall have a downward slope to the factory. This will be found of great advantage when large quantities of coffee-berries are being carted to the factory for treatment. The drainage of the estate will be found much simpler under this plan than if straight, right-angled roads are made, for as the roads will all be running down hill on an easy gradient, the main drains can be made alongside them, and will rarely be crossed by other roads.

Should it be found, after the roads have been made, that the blocks of land are too large for easy inspection, small paths can be made to intersect them, or lines of trees of some other kind can be planted. It should be remembered that, except for cartage purposes, a road will be little used. The trees will always be in lines far enough apart to allow of one walking between, and the coolies will always be found to do this rather than go round a block to get to the other side. Roads are non-producing areas requiring considerable labour for their construction and upkeep, and it is therefore sheer waste to make more of them than are absolutely required.

The planting of avenue trees along every road

has very little to recommend it. Certainly the shaded road is pleasant in hot weather, but on the other hand it is because of this shade that the avenue tree is most to be objected to. The more sun the road receives the better will be its condition; and since in the rainy season sunless days are very frequent, and this is the season when the road will be most used, it will be easily understood that roadside trees are not an unmixed blessing. Further, these trees hinder a free inspection of the fields from the roads.

Of course where Para is planted the trees shade the road themselves, but here there is no help for it. Moreover, the roads through Para will not be used by carts to any large extent. The objections apply chiefly to Coffee fields, where, during the crop, the road traffic will be very great.

The metalling of main roads is a matter that should not be lost sight of. This work can, however, be done at any time.

Drains.—Drainage is not, as a rule, a very serious problem in Uganda. The soil is naturally open, and drains are rarely required for the purpose of sweetening it. They are needed only to carry away the excess water of heavy rains, and to

Coffee, in flower, between Para. Kivuvu

prevent wash, or erosion of soil. Steep hillsides, however, need elaborate drainage. The drains should run round the contour of the hill, and be given only a very gentle fall. They should be close together. The object in view is not to take away as much water as possible from the hill, but to retain it by retarding its downward flow, so that the soil has a longer time to soak it up. Besides causing a loss of water to the plants, the inefficient drainage of steep lands results in heavy wash of the soil, and the consequent loss to the crop of the loose rich top-soil.

In addition to the drains, catch-pits are very useful on steep land. These should be made in places between the drains where wash is likely. They should be about 2 feet wide, 1 foot deep, and about 6 feet long. Such pits will hold a considerable amount of water, none of which can escape except by soaking down to the roots of the crop. The fine soil which they collect during a heavy rain can be removed at intervals, and thrown back on the land from which it was washed.

Another means of staying wash is to plant thickly a low-growing shrub. Species of Crotalaria are suitable for this purpose. The seeds

should be sown in drills at intervals across the slope of the hill. The plants can be kept short by pruning. The Crotalarias are nitrogen-producing plants, and so will rather enrich the soil than otherwise.

Cover plants such as Ground Nuts and the Giant Bean (*Mucuna gigantea*) are also useful for staying wash. The former are, however, likely to attract pigs, and the latter may cause some trouble by climbing the plants. If these plants are used they should be dug into the land when the seeds are ripe. In this way re-sowing may be saved.

On the more level parts of the estate it will be advisable to delay making drains until they are found necessary to prevent wash. It is very much better that all rain should soak into the soil than that a part of it should be run off by drains. Some soils will absorb very much more water than others; but as a rule, unless the slope is fairly steep, our soil in Uganda is sufficiently open and absorbent to readily take up the water of any ordinary shower.

Portioning out the Estate.—If all the three products we are considering are to be planted, the

Coffee, in flower, between Para. Kivuvu

part of the estate to be allotted to each should be considered.

The Cocoa area should first be chosen, as particular regard must be paid to shelter for this crop. The lower slopes, sheltered valleys, and forest glades should be carefully examined with this view.

Para Rubber should not be planted on exposed hills, as young trees are very liable to damage from wind, and growth in wind-swept places will at the best be found very slow. The more exposed parts can be made suitable for Coffee by the establishment of wind-breaks.

The best soil, and most easily cleared land should be taken in hand first, so that as much land as possible can be got under cultivation in the early years.

CHAPTER VIII.

Clearing and Planting

Clearing.—The clearing of "Elephant Grass" land presents few difficulties. The grass is first cut down close to the ground and allowed to lie until quite dry. It can then be cleanly burnt off. The land is then hoed up to a depth of 9 to 12 inches, and all roots shaken free of soil and laid on the surface to dry. This original digging if well done will practically eradicate the "Elephant Grass" and other natural growths.

A few planters use ploughs to break up new land, but as before ploughing all stumps of trees must be removed and ant-hills levelled, it does not greatly reduce the cost of the work. Where bush or trees occur on the land, these should be cut down at the time of cutting the grass, and the branches lopped off and piled for drying. These piles may have to remain many weeks until dry enough to

Para Rubber 4 years old, Coffee between. Kivuvu

burn. The stumps need not be removed, at any rate for a time. It has been proved in other countries that the decaying stumps of trees are a source of disease to the Rubber, but as far as is known, no harmful effects result to the Coffee and Cocoa.

Lining and Holing.—Clearing being finished, the lines for the plants can be marked out, and the holes dug. It will be found convenient to make the lines as far as possible at right angles to the road. This will facilitate inspection of work and checking of tasks. Where the road is straight it can be used as a base in lining, but if curved the base-line must be back from the road sufficiently far to get a long straight line. A line exactly at right angles to this will then be chosen and pegged out for holes.

Subsequent lines are made parallel to the first, and at equal distances asunder. In pegging the line the start should always be made at the base-line. The pegs will then be always square if the distances are kept constant. If the base-line is back from the road, the lines should then be continued from it right up to the road.

We have found a Chesterfield linen tape the best

for measuring. The natives quickly learn to read it accurately, and it is more easily used for different measurements than a chain. It does not stretch or shrink as a cord does.

We are not in favour, as we have already said, of the practice of planting avenues of trees by the sides of all roads, but prefer that the field should continue right up to the road. In addition to the other objections to it which we have mentioned, we may remark that if rubber is used as an avenue tree, as it frequently is, the collection of the crop from such trees will be found expensive, and will also require a great deal of supervision.

We do not favour triangular planting, at any rate for Coffee or Cocoa, for, although it allows of a more regular distribution of the trees over the ground, it has what we consider the disadvantage of not leaving a wider space between the lines in one direction to facilitate collection of the crops.

The lining being finished, holing can be at once begun. It is an advantage to have the holes made several months before they are required; to obviate delay in the planting they should all be finished before the season for it arrives. The men should be taught to make the spot where the peg is the

centre of the hole. This can be done by marking the outline of the hole before the peg is removed.

In ordinarily good soil a hole of from 12 to 18 inches in diameter and depth is large enough for any of the plants, but if the soil is stony or gravelly the holes should be made larger. The soil removed from the hole should be thrown over the surface, not piled round the hole.

When weeding has to be done over a holed field, care should be taken not to break up the outline of the hole, for that would render regular planting more difficult. The silting up of the holes need cause the planter no annoyance : the soil washed in in this way is fine surface soil, which is the very best filling for the holes.

Planting.—The days for this work must be carefully chosen, and it must be energetically pushed on in suitable weather. The work ought not to be hastily commenced as soon as the first rains begin. It is wise to defer it till sufficient rain has fallen to thoroughly soak the soil, and particularly the bottoms of the holes. Showery days, dull days, and mornings after rain should be given up to planting, and every effort should be made to complete the work well before the rainy

season is over. This will give the young plants a chance of becoming established before the next dry season comes. It is much less risky to plant trees a little too early than to wait for them to reach the proper size, if the latter course entails planting near the end of the rainy season.

If care is taken in choosing suitable planting days, watering in the field, or shading, need never be resorted to, except in the case of Cocoa, which must be shaded with palm leaves or grass as soon as planted.

The actual planting of the trees should be done only by the most experienced men. Each man takes his own line right through the field, and the headman in charge ought to know the planter of each line so that bad work can be checked. The planter will be preceded by men who fill up the holes for him. This is done by scraping in surface soil until the hole is half full. It should then be trodden firmly, and the hole filled loosely with good soil. Another gang of men will be employed in carrying plants from the nursery to the planter.

The planter will need to provide himself with a trowel with which he makes a hole in the loose soil large enough and deep enough to take the

UGANDA PROTECTORATE

SHOWING IN RED THE DISTRICTS WHERE PLANTING IS BEING CARRIED ON

plant. He then takes a plant from the carrier and places it in the hole, firmly treading the soil around it.

When the soil is properly trodden down the plant ought to be at the same depth in the soil as it was in the nursery bed before removal. It should be firmly fixed in its place, and the soil around it made level and very firm. The planter must not turn up the tap-root in planting. He cannot avoid doing it, however, if he makes the hole too small or too shallow. It is necessary to have a responsible man at the nursery to give out the plants. This man should see that only good strong plants are taken, and that those dug up from beds are not damaged, or the soil shaken from their roots more than can be avoided. It is his duty, too, to see that each man carries a certain number of plants, ten or twenty as the case may be. This will be found a great help in checking the number planted each day.

For carrying plants dug out of beds a wide box or basket is best. Only a limited number of plants should be put in each, so that the planter can easily lift out a plant with its ball of earth without disturbing the remainder. While being carried

from the beds to the field the box should be covered with banana leaves to keep the sun and air from the roots of the plants.

The plants should be removed from the box only by the planter, who should take them one at a time as he is ready to plant them, the carrier keeping beside him until his box is empty.

These instructions may seem to the inexperienced to be unnecessarily minute, but if they are observed it will be found that the work will go on rapidly and smoothly, and be well done. A gang of 50 men working as recommended above will put down in a day about 10,000 plants. The men will, of course, require very close supervision to ensure that everything is properly done; and as the piece-work system tends to put a premium on hasty work, it should be specially avoided by employers in this department of industry.

If a morning that has been suitable for planting operations should open out later into a dry sunny day, it will be wise to suspend the work until the atmospheric conditions are again favourable.

Distances of Planting.—There is much difference of opinion as to the best spacing for the various crops; and experience in Uganda is not

yet sufficiently extended to entitle anyone to dogmatise on the subject. The experience gained in other countries can be useful only as a guide in the conduct of our own experiments. The nature of the soil of the individual estate is a factor which may upset any general rule. On a poor soil more trees per acre may be planted than on a rich soil. The following distances are, as far as our experience goes, the best to work from :—

Para Rubber alone	20′ × 20′.
Cocoa	13′ × 10′.
Coffee, Nyasa variety	8′ × 6′.
Coffee, Bourbon variety	8′ × 8′.
Para Rubber interplanted with Coffee...	24′ × 24′.

This spacing will, we believe, allow the Coffee and Para Rubber to reach the maximum size in good soil. With Cocoa it will probably be found necessary to cut out every other tree after 12 or 15 years. This will leave the trees finally 13′ × 20′, which we do not think will be found too great a distance eventually, although it would be much too great up to the twelfth year. The planting of the trees at 10 feet will allow of almost double the crop being secured from the area for several years, and with the closer planting, upkeep expenses will

be lessened. The Cocoa tree is slow in growth during its early years, and as it crops at five years old the intermediate trees will have given good returns before they need be cut out, and the permanent trees will not be in any way injured.

Interplanting.—In the case of Para Rubber interplanting with Coffee will be found of immense advantage.

If Coffee is thus used as a "catch" crop, it is best to plant the Rubber 24′ × 24′, as this will allow of the Coffee being retained for a longer time without any undue interference with the Rubber. The Rubber will be thus 75 trees to the acre, and the Coffee 825 per acre. The Coffee nearest the Rubber would have to be cut out after the fifth year, and the whole removed after the seventh year. The following diagram shows this method of planting, and the plants which should be first cut out.

Cocoa 5 years old, between Para. Botanic Gardens, Entebbe

This would reduce the Coffee trees by 353 per acre and leave 472 per acre.

It is of course a fact that any interplanting will, to a certain extent, interfere with and retard the Rubber, but the planter will, we take it, not mind whether his profits are from Rubber or Coffee, as long as he secures them; and the advantage of an interplanted area over an area not interplanted is so immense as to form an overwhelming argument in favour of the interplanting system. It is well, however, to bear in mind that the Coffee must be sacrificed at the right time.

Fig. 24 shows Para interplanted with Cocoa. Apparently both crops are doing well. There are, however, more reasons than one against this practice. Firstly the shade given by the Para tree cannot be controlled without damaging the tree. Secondly, it has been found that canker will attack both Cocoa and Para, and the separation of the two crops is thus advisable.

Annual crops, such as Maize, Beans, Sim-Sim, and Ground Nuts may be permitted between the young plants for the first two years, but they should be sown in rows, and not close up to the

plants. Sweet Potatoes, Yams, and Cassava should not be allowed amongst any of the crops.

Provision of Shade.—It is only for Cocoa that shade is necessary, and how far this may be an advantage with mature Cocoa remains yet to be proved. The Banana gives an ideal shade for the early life of the Cocoa, but is found unsuitable after the fifth year. It is also useful as providing large quantities of native food. By the fifth year some more permanent shade should be provided, such as Dadaps (*Erythrina*) and Albizzia, which can be easily controlled. It is still, as we have said, an open question whether the provision of any shade at all is advisable in Uganda, but until this has been decided it is perhaps the safer course to provide it. In opening a new field for Cocoa it is an advantage to plant the Bananas six or nine months before the Cocoa.

Wind-belts.—Amongst Para and Coffee wind-breaks will be found of the greatest use. The extent and frequency of these must depend upon the force of the prevailing winds. In Para fields they will only be a temporary institution whilst the trees are young. In such a case the Ceara Rubber

(*Manihot Glaziovi*) is a very good tree to use, owing to its rapid growth and dense head.

For more permanent breaks, other trees can be planted, such as Nsambya (*Markhamia platycalyx*), Lubugo (*Ficus spp.*), Conifers, Jak Fruit (*Artocarpus integrifolius*), Mango (*Mangifera indica*). The trees in the wind-breaks should be planted closely together, and thinned out when necessary.

CHAPTER IX.

Weeding and Upkeep

KEEPING the land free from weeds absorbs the largest amount of labour, and is the most costly of all the operations in the plantation. It is necessary, for the good growth of our crops, that they shall not have to compete for space, below ground or above, with any of the wild growths of nature. Our plantations are at present only small clearings in a vast extent of jungle, from which seeds of all kinds are blown in in countless numbers. Our rich soil and well-distributed rainfall gives these seeds every opportunity to germinate and establish themselves, and only by constant labour can they be kept under. Fortunately, the land generally chosen for plantations, "Elephant Grass" land, contains practically no other growths, and as the "Elephant Grass" is easily eradicated, most plantations start in a clean state after clearing has been properly done. After the

"Bisagazi," "Elephant Grass" (*Pennisetum setosum*)

"Lusanke" (*Imperata arundinacea*)

removal of the large growth, however, the small weeds get their chance; and in the fine tilth, every seed dormant in the soil, and all those blown in, have a splendid medium in which to grow.

A study of our commonest weeds will be found full of interest, and of great value. The means to adopt to keep them in check must depend upon the nature of their growth and their methods of propagation. The system of weeding which will be most effective will be that system which most interferes with growth and propagation.

Types of Weeds.—After the clearing of the "Elephant Grass," a very varied crop of weeds springs up, with no very noticeable preponderance of any species. A few months' cultivation disposes altogether of many species, and those which persist year after year are less than a score in number. The following are the twelve most common kinds :—

	Botanical Name.		Native Name.
Annuals	Amarantus blitum	(Dicot)	"Mbogi."
	Justicia matammensis	(Dicot)	"Kamukasa."
	Bidens pilosa	(Dicot)	"Sere."
	Digitaria fenestrata	(Monocot)	"Kuku."
	Eleusine indica	(Monocot)	"Kasibanti."

	Botanical Name.		Native Name.
Succulents	Commelina nudiflora	(Monocot)	"Nanda."
	Commelina africana	(Monocot) Blue	"Nanda."
	Portulaca oleracea	(Dicot) Yellow	"Sezera."
	Portulaca quadrifida	(Dicot)	"Bwanda."
Couch Grasses	Digitaria mutica	(Monocot)	"Lumbugu."
	Mariscus sp.	(Monocot)	"Nku."
	Imperata arundinacea	(Monocot)	"Lusanke."

Of these twelve species, seven are monocotyledons, and five dicotyledons. The monocotyledons are our worst pests.

According to their methods of propagation, the weeds may be divided into three distinct classes. The first class consists of those which propagate only by seeds. These may be termed *annuals*. In this class come Mbogi, Kamukasa, Sere, Kuku and Kasibanti. It contains dicotyledons and monocotyledons.

The second class consists of those which, besides propagating by seeds, have a fleshy growth which is capable of spreading along the surface of the ground, and rooting. Such weeds will re-establish themselves even after being uprooted. Small pieces, cut off, will quickly form new plants.

"Kasibanti" (*Eleusine indica*)

"Nku" (*Mariscus sp*)

"Lumbugu" (*Digitaria mutica*)

"Kuku" (*Digitaria fenestrata*)

These may be termed *succulents*. In this class are included Nanda, in two species, and Bwanda. They are all dicotyledons.

The third class consists of those weeds which, besides seeding, propagate themselves by underground rhizomes or stems, extending from the parent plant in all directions, and forming new plants. In this class are Lumbugu, Nku, and Lusanke. They are all monocotyledons and grasses, and may be termed *couch-grasses*, although none of them are exactly what is known by that term in England.

Plans to be adopted to keep weeds in check.— The weeds are all alike in that they will propagate by seed; so that weeding should be at such short intervals that perfection of seed is impossible. The shortest period in which seedling weeds can grow up and ripen their seeds is about a month. The "Kuku" grass and "Sere" will ripen seeds in this period, both often flowering whilst only in the seedling stage. Weeding should therefore be done at intervals of not more than three weeks.

With the annuals, this is all that has to be considered, for the weed once dug up soon dies, and it can be either left on the surface of the ground or

buried. The succulents, however, will not die if merely dug up and left on the surface of the ground. The stems all have the power of rooting very quickly, and in a very few days the growth is going on as if no disturbance had taken place. An easy and effective way of destroying them is to bury them in the ground. For this purpose, shallow holes may be dug by the weeders, between the trees, and then the weeds can be trodden in and covered with 6 inches of earth, which will effectually smother them.

For the couch-grasses, different methods again must be adopted. Every part of these is capable of rooting and growing into a perfect plant, and this it can do either on the surface of the ground or under it. The only way to destroy these weeds is to burn them. They are the worst of all weeds, owing to their habit of spreading underground unseen.

Wherever any of the couch-grasses occur, in new land or old plantation, they must be dug up, and every small portion removed from the soil. Of the three, "Lumbugu" is by far the worst, and too much care cannot be taken to prevent its spread The weeders should be instructed to dig it out

"Kamukasa" (*Justicia matammensis*)

"Mbogi" (*Amarantus blitum*)

"Sere" (*Bidens pilosa*)

"Sezera" (*Portulaca oleracea*)

completely wherever found, and to remove it from the field to be dried and burnt. Such weeding ought not to be given out as task work, or it may be carelessly done. Constant supervision should be exercised over the weeders.

It will be gathered from what has been said above, that intelligent weeding of a plantation is necessary if it is to be kept in order at moderate expense, and that it is not an operation which requires but little supervision beyond the checking of areas. The appearance of weeds should be watched for, and they should, as they appear, be identified and dealt with effectively. The annuals are the first to appear on a new plantation, but the others soon come in small numbers. A few months of indiscriminate hoeing, however, will result in the establishment of all these persistent weeds in large colonies, which it will take an immense amount of labour and money to eradicate. The writers know of instances where "Lumbugu" has cost so much as £10 per acre to remove completely.

Where so much discrimination is necessary, if good results are to be obtained, mechanical weeders and cultivators need not be expected to give satis-

factory results in the long run. Such machines will do good work, whilst the trees are young, in keeping down the annual weeds; but whilst they are being worked, and are cutting up all the weeds alike, there is the possibility of the couch-grass, whose roots are permeating every inch of the soil, being overlooked. Mechanical cultivators have been used, in some cases with disastrous results. In other cases, the results have satisfied the planters, but whether in general the machine is as effective in clearing the ground of weeds as the hand is a question which still remains to be decided. A high authority on the subject once stated that the work on tropical plantations might be more correctly described as "extended gardening" than as "agriculture." There is no doubt of the truth of this; and the more we apply the principles of gardening to all our operations, the greater our success will be. In all the tropical plantation countries of the world, farm implements have been tried, and given up in favour of hand cultivation.

Cover Plants.—A few years ago, a great deal was heard of the possibilities of various selected weeds as cover plants to the soil. It was claimed that these plants, which were of the order

"Nanda" (Yellow) (*Commelina africana*)

"Nanda" (Blue) (*Commelina nudiflora*)

Leguminosae (many species of which have the power of collecting the free nitrogen from the air) would by their own growth so completely cover the soil, that other weeds had no chance to grow. Their powers of absorbing nitrogen were said to prove a valuable aid to the Rubber among which they were planted; and altogether Rubber so grown was expected to develop as rapidly as clean-weeded Rubber, and at a very small expense for upkeep. The plan was, however, extensively tested in Malaya, and it was conclusively proved that better growth resulted from absolutely clean weeding.

The cover plants were tried with Para only, but there is no doubt that with Coffee the failure would have been even more pronounced. Nothing but clean weeding can be practised with Coffee. A very moderate growth of weeds, even for a few weeks only, has a noticeable effect on the trees. The leaves take on a pale hue, and growth is much restricted. If the trees are young, the result can be seen for a year after in the short internodes, and small leaves of the growth so affected.

We have seen a field of Coffee interplanted with lemon grass. The grass was cut periodically and

used as a mulch to the Coffee. The effects of the interplanting were well nigh disastrous. The Coffee plants made very poor growth and bore little, whilst in the dry season they became almost leafless. On the lemon grass being uprooted, the Coffee at once began to recover, and in the course of a few months it entirely regained health.

In one instance we have used cover plants to some advantage amongst mature Cocoa which was too widely planted. After the removal of the banana shade, it was found that a great part of the surface of the soil was subject to the direct rays of the sun. This is detrimental to the soil, and also to the Cocoa, which loves a shaded soil in which to spread its fine surface roots. The field was sown with the "Giant Bean" (*Mucuna gigantea*), which creeps over the soil, and forms a thick carpet of growth; and the Cocoa appeared to derive some benefit from it. There was practically no diminution in cost of upkeep, as the beans had to be carefully weeded, and had also to be kept under control, to prevent them from covering all the soil, or climbing the trees. Ground nuts would serve the same purpose, but they do not last as long in growth as the bean. There must

be no removal of the crop of nuts. These should be dug in to enrich the soil.

Pruning.—This is a very important operation on the estate, and it must be entrusted only to skilled men. The object in pruning is to alter the natural growth of a tree to that which the planter considers more suitable to his purpose, and more likely to prove productive. That production can be increased by pruning is too well known to need argument. The bearing wood on a Cocoa or Coffee tree can be increased both in quantity and vigour by proper pruning.

Not a great deal of pruning is necessary in our plantations at the present time. Para requires very little attention. The pruning of Coffee is an open question which is discussed elsewhere. Our Cocoa has not reached the age when much pruning is required, but still very much can be done by way of improving the shape of young Cocoa, with very little expenditure of labour.

Para.—In the early days of Rubber growing, the topping of young trees which had reached a considerable height without branching was recommended. This was called thumb-nail pruning, and consisted of nipping out the terminal bud of

the growth to force side buds into activity. Experience of the effects of this practice has resulted in its utter condemnation. Branches so formed all spring from the tree at the same point, and form such an angle that they drop off when they attain to a fair size and weight, often splitting the trunk right to the ground in doing so. This has occurred on our estates in Uganda, so that we have experience to convince us that the practice is not one which ought to be adopted.

A small percentage of trees will grow very high before branching, and with these there is considerable delay in putting on girth; but eventually they will form heads and thicken out, and such branches will be found to withstand the storms in a way that forced branches will not do.

The only pruning which should be practised on Para trees is the removal of any branches that may be growing on the lower 6 ft. of stem. This portion is required as the tapping area, and it should be straight, clean, and unbranched. Shoots should therefore be removed thence as soon as they appear. They can be rubbed off if still soft.

Cocoa.—The ideal Cocoa tree should have, low down, as many branches as possible, but without

overcrowding. The young plant should form three primary branches at 2 ft. from the ground. These should each form three secondaries at 4 ft. from the ground. Branching should again take place at 6 ft. from the ground. Where more than the required three branches are produced, the weaker should be removed. Such a tree will have a fine foundation or framework on which to carry a big head of foliage. Most of the plants will be found to break naturally at about the right place, but occasionally one will run up several feet without doing so. Thumb-nail pruning can be practised to force branching with success.

There is a double advantage in keeping the crown of the Cocoa tree low. Firstly, as it is the thick branches of the crown which bear the crop, the cropping area is brought more within reach of the picker, and secondly, such trees withstand winds very much better than those which have a similar crown on a stem several feet high.

The framework of the tree having been formed, further pruning consists of cutting back strong growths which may spoil the balance of the head, or which are unduly vigorous; the removal of superfluous growths that the head may not become

too dense; and the cutting out of all weak useless growth, particularly about the middle of the tree.

At all times, Cocoa is prone to produce strong fleshy shoots at the base or on the main stems. These growths are known as suckers. They should be removed as soon as seen. On a plantation of considerable size, it will pay to detail a man to go continually over the Cocoa fields to look for, and remove, the suckers.

Coffee.—The question of the advisability of pruning Coffee for crop has been discussed elsewhere, and an account of the method to be adopted is there given. All that need be dealt with here is the necessary pruning and stopping of the tree.

The tree must be kept to one stem. Second stems result, not from ordinary branches, but from suckers which spring only from the stem of the tree. These should be removed as soon as they are seen. Topping should be done when the tree is about $5\frac{1}{2}$ ft. in height. All that is necessary is to pinch out the growing tip. The topping will cause suckers to appear abundantly all up the stem of the tree.

It is advisable to have pruners always going through the fields removing suckers. These men

should be provided with a stick $5\frac{1}{2}$ ft. long, with which to measure trees for topping.

We have followed the practice of not stopping the upward growth of the tree altogether at $5\frac{1}{2}$ ft., but of allowing further top growth up to $6\frac{1}{2}$ ft. The top is pinched out at $5\frac{1}{2}$ feet. This results in two shoots from the top node. One of these is removed at once; the other is allowed to extend a foot or so, and is then stopped. We find picking presents no difficulty at this height, and the after-growth at the top appears to result in the more perfect development of the branches of the upper half of the tree. It has also the effect of preventing a dense growth of branches at the base.

Manuring.—Probably no operation of the plantation is more misunderstood than that of manuring. Amongst amateur planters, the idea seems to exist that a plant or tree is capable of absorbing any amount of manure, and that applications of it should be followed by corresponding increases in crop.

A new rich soil, such as ours, contains ordinarily everything required by the plant. No good purpose is served by adding manure if satisfactory growth is being made without it. A plant finding

everything it requires in a natural soil cannot be usefully hastened in growth by the addition of more food to its roots. Strong fertilizers will have the harmful result of forcing a soft, fleshy and unfruitful growth.

As a general rule, no manure should be thought of until the trees are cropping. There may be exceptions to this in the cases of very poor soils, but then such soils are unsuitable for plantations, and should not have been chosen.

A soil is impoverished only to the extent of the crop removed from it; and against this must be placed the return made by the trees in the shedding of their leaves, the addition of nitrogen carried from the atmosphere by rain, and the action of the roots of the trees and cultivation in aiding nitrifying bacteria in the soil to bring into an available condition the large stores of unavailable food. One per cent. of nitrogen in an analysis means 30,000 lbs. per acre in the top 12 inches of soil. The amount of nitrogen removed by an average crop of Coffee or Cocoa we are not aware of, but we know that a wheat crop removes 20 lbs. So we see how vast are the stores of plant food in a good soil, and how much we can increase fertility

by assisting nature to render these stores available to our trees.

Nothing will so assist the work of the minute bacteria or ferments of the soil in their task of converting nitrogenous matter into soluble plant food as good tillage, which results in the conservation of moisture and the correction of acidity.

Trees suffering from an insufficiency of food will soon render this apparent by their poor growth, and failure to perfect good crops. When this occurs, artificial manuring must be resorted to. The kind of manure best suited depends upon the crop and the nature of the soil, and here chemical analysis can give the best advice by showing where the deficiency is.

It has been proved over and over again that on an average soil no system of manuring gives such good and lasting results as mulching, farmyard manure, weeds, leaves, etc. being used for the purpose. The use of an artificial fertiliser would give a quicker return, but over a long period, mulching has proved its superiority. This system of manuring cannot be harmful to even young plantations. It is a convenient manner of getting rid of our weeds and estate refuse, such as

fermented coffee pulp; and the decomposition of this material will result in only a gradual supply of natural plant food. For many years to come, the use as a mulch of such materials as we find to hand will be all that our plantations will require in the way of manuring.

The manner of applying manure may be briefly referred to. The practice in temperate climates is to apply manure to vacant land, or amongst trees in the dormant season. The manure is then ploughed or dug in to ensure that no loss of its properties takes place by exposure to the air. This practice must not, however, be attempted with our crops. All our trees are surface rooting, and any deep digging in order to bury manure would result in the destruction of the feeding roots which alone can take up the manure. The manure should be spread over the surface of the soil, and rains will wash it down to the roots of the trees.

A system of manuring termed green manuring has been extensively practised in recent years. This system consists in growing a selected weed of the leguminous order, and cutting it down and returning it to the soil before flowering. Leguminous plants have the power of fixing the free

nitrogen of the air, and are of a high manurial value. Green manuring results in large additions of organic matter to the soil, in the improvement of its mechanical condition, and in the consequent increase of its capacity for the retention of moisture.

CHAPTER X.

Factory and Machinery

To deal with the crops in an economical manner machinery is necessary. Hand machinery could be used on estates not exceeding fifty acres; but for any acreage beyond that power machinery must be provided. For Cocoa and Para, very little machinery is necessary, but a considerable amount of it is required to deal effectively with large crops of Coffee.

A point should be made of having the factory in working order before the first big crop comes in. This crop will be ready in three years from the time of sowing, and it should be borne in mind that it takes many months to get machinery out to Uganda, and to fully equip a factory there. Nothing is gained by putting off the erection for six months, and a great deal of loss may result if the machines are not ready to deal with the crop. It will also be found more economical to do this

heavy work slowly and when spare labour is available, than to have to push it on at all costs against time.

Site for Factory.—The first point to be considered when choosing the site is the possibility of a good permanent water supply. We may state here that the supply necessary for pulping Coffee by power is about 800 gallons per hour. On a few favoured estates a good spring of water occurs at a high level. By means of a pipe line, this can be run direct to the machines, obviating the need of a pump. Means must be provided for the storage of the water, so that a large quantity may always be available. The storage can be arranged for either at the factory or at the source. The latter place is preferable, as it will give water under considerable pressure at the factory, and it will not then be necessary to provide large storage tanks for the factory.

If there is no such source of water supply convenient, the site for the factory must be near the supply, so that a pump can be used to raise the water to tanks at a level above the machines. Here also a reservoir should be built, so that there may always be a reserve of water to draw on. It is

very unlikely that the stream will be of sufficient size and permanence to enable one to pump direct from it.

If possible, the site should be near the centre of the plantation. This will save a great deal of transport in bringing in the crop to be treated. The site should be sufficiently large for any possible extension of buildings. There should be an acre or two of unoccupied land around it to afford space for sundrying the produce. This space must be clear of all trees.

Building.—The plan of the building will, of course, largely depend upon the taste of the planter; still it may be of use to some to give a rough idea of what a suitable building should be in dimensions. For a building with an upper floor, 65 ft. by 30 ft., ground area is sufficient to contain machinery capable of dealing with the produce of a large estate. Still we would not recommend a smaller building, even on a small estate. If an upper floor is not added, the building must be larger. We strongly recommend a double-storied building, however, as it is of the greatest convenience in feeding the machines. It also affords a large airy floor space, on which half-

dry Coffee can be spread, if the crop is coming in faster than the drying apparatus can deal with it. The height to the first floor will depend upon the method to be adopted in fixing the shafting, but about 10 ft. will be found sufficient. The height of the second storey need not exceed 6 ft.

The framework of the building may be of timber or steel. If there is timber on the estate, the former would be the cheaper. If the shafting is to be supported on the building, this must be provided for by making the foundations and framework substantial enough to carry it.

The building should contain machinery only, the washing tanks for Coffee and Cocoa being outside. A Rubber drying shed would also be separate, as would the stores. Above each machine, on the upper floor, large bins can be built. A pipe from these should come through the ceiling to the machine, and if a regulator be attached to the pipe, the machine can be easily made self-feeding. Coffee to be treated could then be shot into the bins, whence it would run direct into the machines at the proper speed.

Besides the factory, other buildings are required. These will be a Rubber drying shed, a store for

Coffee, and a large open shed in which the trays used for sun-drying can be placed under cover at night, and during storms. All these buildings should be as near the factory as possible. They can be made of any size, and enlarged as may afterwards be found necessary.

Machinery.—We do not propose to recommend any particular machines or make of machinery, but merely to indicate what is required. The machinery should in every case be obtained from a reputable maker. Catalogues should be carefully studied and advice sought from experienced planters. Machines of ample capacity should be selected. The makers will always be found willing to advise in the selection of a machine, but the planter must finally decide what best suits his individual requirements.

Engine.—This is the first thing to be considered. It should be of ample power, and of the kind most economical to run on the estate it is intended for. On large estates it is advisable to have a second engine also fitted up as a stand-by against a break-down. A failure of the engine in the middle of a Coffee crop would be attended by disastrous results.

Pulper.—This is the machine for taking off the outside jacket of the berry, and reducing it to parchment Coffee. The pulper is fitted to a cyclindrical separator, which separates any unpulped berries that may go through.

Pump.—This should be sufficiently powerful to feed the pulper with water.

Drier.—In our climate it is necessary to resort to artificial methods of drying, as we have always a humid atmosphere, with particularly heavy dews at night. Moreover, Coffee always ripens in the rainy seasons. A good deal of sun-drying can be done, but it is quite impossible to deal with any large amount of Coffee without the aid of a drier. We find artificial drying a cheap process, and one which does no injury to the Coffee. Of a consignment sent home, half sun-dried and half machine-dried, the half treated in the latter way fetched the higher price. We do not believe the sliding roof arrangements, much used in other countries for drying, will be found efficient in our moist climate. The markets want good, bright-coloured Coffee, and quick drying is the only way to secure colour.

Peeler, Polisher, and Grader.—These three

machines are all made to work together as one. They will be needed, if it is desired to clean and grade the Coffee ready for sale on the estate. The question of the advisability of estate-cleaned Coffee is discussed elsewhere. The Coffee can be shipped in parchment and cleaned at the docks in London before being sold.

Rubber Machinery.—To deal with our Rubber for several years ahead an ordinary crepeing machine will suffice. On estates where the output is large, more elaborate machinery is necessary. Artificial drying is also resorted to, but it will be several years before we need to think of such processes.

Erection of Machinery and Arrangement.—It is not necessary to follow strictly the plans set out by the suppliers as regards the disposal of machinery, but their working plans for erection should be rigidly adhered to. The work should be done under the supervision of a competent engineer.

CHAPTER XI.

Collection and Preparation of Coffee

Picking.—The operation of collecting the crop is a very simple one, but it demands a large amount of labour and must be performed at a definite time. The period over which berries may be allowed to remain on the tree after becoming ripe is only a few days. The pulp surrounding the beans then commences to decompose, and the berry drops off. If the berry is over-ripe pulping is not cleanly done, whilst decomposition results in stained or black parchment. The picking of unripe berries must be guarded against, as a small proportion of these will result in an uneven sample of Coffee.

The berry is ready for picking when it has turned red. Occasionally, in very wet weather, the berries will not assume a bright red colour, but remain, even when fully ripe, a dull yellowish colour. A good test of ripeness is to pick a few berries and press them between a finger and

thumb. If ripe the beans will easily shoot out of the jacket, and be quite free of it. If unripe it will take considerable pressure to separate them from the jacket. If the trees are cleanly picked it will be found sufficient to go over the fields at intervals of six days.

A considerable amount of supervision is necessary to prevent waste in picking. The men will, of course, do the work by task, but it will be necessary to secure that it is properly done. Each picker should take a row of trees, except in the case in which small children are employed, when it is advisable to put a child and an adult together, as the children cannot reach the upper branches of the trees. The pickers should entirely finish each tree before leaving it for the next, and a rule should be made that when a tree has been picked all dropped berries must be picked up from the ground underneath. A few berries always drop off, and more are dropped by the pickers. Considerable waste takes place if these are not gathered up.

We have found it pay to give the men demonstrations in the best way of picking. Although the work is performed as task work, it is in the

interests of the employer that the men shall complete it as easily as possible. A new man will be observed walking round a tree picking a berry here and there, his basket probably at the next tree, where he will walk with a handful of berries. Such a man gets disheartened as the day wears on and he sees no chance of fulfilling his task. The trained picker, however, will be found to start at the top of the tree, and, taking each branch as he comes to it, strip it of the ripe fruit. He keeps his basket at his feet and picks with both hands.

The picker, when his measure is full, carries it out to the nearest road, where the Coffee is bagged, and the fact is recorded to his credit. From here it is carted to the factory. The berries are then weighed and shot into the bin, ready for pulping.

Pulping.—This consists of the removal of the outside red jacket of the berry. It is a very rapid process, and unless very large quantities of Coffee are coming in, it is not necessary to run the pulper for more than a few hours daily. In this case it is best done in the afternoon so that the day's picking is finished up, as the berries would not pulp so well next morning. For the best work it is necessary that the machine be carefully adjusted

and run at the correct speed, that the Coffee be freshly picked, and that abundant water be used to run through the machine with the Coffee. Even then a certain amount of pulp will be found amongst the beans, and to a small extent this cannot be avoided. The pulp can be picked out by hand, or it can be winnowed out when the Coffee is dry.

Fermenting.—Newly pulped Coffee is covered with a thick, slimy, sugary substance which is difficult to remove at this stage. If dried in this state the parchment would be dirty in appearance, sticky, and dry very much slower. This coating is easily washed off after the sugar has been acted upon by fermentation. It should be noted that this is the sole object of fermentation. There is, in the process, no intention of altering the flavour of the bean; the object is merely to clean it.

Fermentation is accomplished by running the Coffee into tanks from the pulper, and allowing it to stand there until the process is complete. This takes in Uganda about twelve hours. Water can be added to the Coffee in the tanks, but it is not necessary as the beans are wet enough to ferment without it.

Washing.—This is the next process the Coffee undergoes. Plenty of water must be used, and the operation thoroughly carried out. A test of cleanliness is easily made by taking a handful of washed Coffee, and noting if it shows any traces of sliminess. If it does, either the washing or the fermentation is incomplete.

Drying.—Immediately after washing the drying can be commenced. This is the longest process in the preparation of the Coffee. For sun-drying about 10 full days' sunshine is necessary, and as it is the rainy season when our crop ripens, the drying often occupies weeks. Hot-air driers are made which will completely dry the Coffee in 24 hours. For sun-drying, trays should be made of $\frac{1}{4}$-inch woven wire which is sold for the purpose. The trays should be 6 ft. by 3 ft., and 3 in. deep. Only about 1 in. deep of Coffee should be put in each tray, and it should be repeatedly stirred to allow of regular drying. The trays should not be put on the ground, but supported on a frame-work two or three feet high. This will assist the drying by allowing a circulation of air under the trays. It should be noted that quick drying is essential to secure good bright-coloured Coffee.

The most economical method of drying, perhaps, is to use both sun and machine. The wet Coffee could be put in the trays to dry partially, and be removed into the drier to finish when the amount in the trays becomes too great.

The driers are divided for convenience into four sections, each of which can take Coffee in a different stage of dryness, so that nothing is lost by one section needing less drying than the others. It is not practicable to dry the Coffee against time. The beans should be tested regularly and with care, as dryness approaches, and removed at the right time, quite dry, but not over-dried. A little experience will enable the planter to distinguish dried from undried Coffee by appearance.

Wet Coffee if cut through appears white in colour. In drying it changes to a dark, almost black, colour, whilst when quite dry it turns light again. Another test is in the feel of the parchment. If quite dry the parchment is very brittle and can be pressed to dust in the fingers. The bean, when dry, is very hard and cannot be dented by the teeth. This is perhaps the best sign for the inexperienced to go by.

The greatest care should be taken to completely

dry the Coffee before shipment. Wet Coffee will quickly turn musty, and the musty smell is very difficult to get rid of.

We find amongst a few planters an idea prevalent that in the first stages of drying the process must not be too rapid, and that Coffee must not be put directly in the sun when washed. Our experience is directly opposed to this idea, and we consider the planter will be very ill-advised to miss an hour's sunshine if he can help it. We have found our Coffee lose considerably in colour with too gradual drying, owing to sunless weather.

Peeling, Polishing, and Grading.—This work can be done on the estate or in London. There is a good deal of difference of opinion as to the advisability of estate cleaning, and at present we do not feel in a position to advise either way. Certainly London cleaned Coffee realises a few shillings more per cwt., but against this we have to put a 20 per cent. increased freight, due to the weight of the husks, and a 50 per cent. increase in cost of bags, for the cleaning reduces the bulk by about half. The London Brokers tell us that in the event of a dull market, London-cleaned would be in demand, whereas country-cleaned might not

be bid for. There is doubtless a good deal of truth in this, and the fact that the London cleaners are able to grade to the demands of the day is also important. The difference to the planter is only a shilling or so per cwt. either way.

The process of peeling, polishing, and grading is a very simple one : provided the machines are correctly adjusted, it is sure to be correctly done. The adjustment necessary is to have such pressure on the peeler that whilst it removes all the parchment it does not injure or break the bean. The Coffee comes out graded into four sizes. It is considered a good plan to hand-pick the two best grades, removing any discoloured or broken beans to make the appearance of the sample as even as possible.

Packing.—Whether the Coffee is shipped in parchment or cleaned, packing should be done at once. Double bags are necessary to comply with East African regulations. The bags should be previously stencilled with all the necessary marks, and, if intended for cleaned Coffee, with the grade also. As soon as a consignment is ready it should be shipped. The quicker the Coffee is put on the

market the better will be its colour, and the higher the price secured for it.

Losses in Preparation.—The reduction in weight in pulping and drying the parchment is great, not less than 77·8 per cent. There is a further loss in peeling of 20 per cent. of the weight of parchment, or a total loss in the whole process from wet berry to cleaned bean of 82·2 per cent.

100 lbs. Cherry Coffee gives 22·2 lbs. dry parchment; 22·2 lbs. of parchment gives 17·8 lbs. clean bean; or, roughly, 6 lbs. of Cherry to 1 lb. saleable Coffee.

CHAPTER XII.

Collection and Preparation of Rubber

Implements.—The selection of these is the first consideration in commencing to tap; and the many patent tapping knives existing offer a wide range of choice. Many knives are made with attached guards, which render it impossible to tap beyond the depth for which the knife is set. Theoretically, this is exactly the principle required in a knife to be used by the native labourer, but, unfortunately, the bark differs enormously in thickness on individual trees, and as the only section containing the lactiferous vessels is the inner layer of bark, tapping at a uniform depth throughout the plantation would produce little Rubber. The sort of knife we have described would have to be set differently for almost every individual tree, and a mistake in setting would have as ill results as deep tapping without it. It would, in fact, call for as much discrimination on the part of the tapper as the use of an unguarded knife.

We have tried many knives, and have finally decided on the simplest form of implement, without a guard at all. This is the "Burgess Gauge" patent. This knife is in the form of a chisel with an almost right-angled cutting edge. It can be used by pushing or dragging. It is light in make, easy to use, and curved so that there is no difficulty in reaching any part of the trunk with it. Other advantages it possesses are that it is easily sharpened, and is cheap in price. Skill in its use is, of course, necessary to enable the tapper to use it quickly and with precision; but we believe the necessary skill is attained more quickly with this knife than with any other we have seen. The "Gauge" is a paring knife only, but the makers supply a suitable knife for making the initial cuts. The latter is, of course, only necessary in opening a new cut. Writing of the "Burgess Gauge" knife in the latest Annual Report of the Botanical, Forestry, and Scientific Department, Mr. W. R. Rutter says :—

Previous to the adoption of the "Burgess Gauge" tapping knife by this Department, the Para trees in the Gardens did not yield latex commensurate with their age and girth. This was thought to be on account of climatic influences, but it was discovered that the trees had not been tapped deep

enough, owing to the blade of the tapping-knife which was then in use being too shallow to cut clean on to the cambium. The "Burgess" knife has the advantage of enabling the tapper to cut right down to the cambium. Care, of course, must be exercised by the tapper to see that he does not cut through the cambium. Tapping was commenced with the new knife on 1st January, and continued till 31st March; it will be observed by the results obtained, a resume of which is given, that a very fair yield may be anticipated from Para trees in this country.

The use of a pricking implement to be used alternately with the paring knife is now practically discontinued. The results following pricking were found most injurious, an exceedingly rough bark renewal with many woody growths being produced, which rendered retapping a most difficult matter. There is, moreover, very grave doubt if the yield in Rubber per unit of bark was increased by pricking in addition to paring.

The collecting cups for the latex and all vessels in which it is afterwards put should be of glass or enamel-ware, or some other easily cleaned material. Dirty vessels quickly contaminate the latex. It is almost impossible to keep tin sufficiently clean.

Tapping.—We do not propose to discuss all the various systems of tapping which have been evolved, but shall confine ourselves to what has

Full spiral tapping. Botanic Gardens, Entebbe

been done in Uganda, and what we consider best for our plantations in their present stage of development.

The principle of modern tapping can be described in a few words as the opening of a wound in the tree and keeping it open by frequent paring of its lower edge, allowing it to heal downwards. The wounds are made diagonally, so that the latex will run to one end of the cut to be there collected. They are often made opposite to each other, meeting at the base to form a wide V. Several V's placed one above another with a vertical cut connecting them form what is termed a herring-bone system. The half herring-bone is the vertical channel with oblique cuts on one side only.

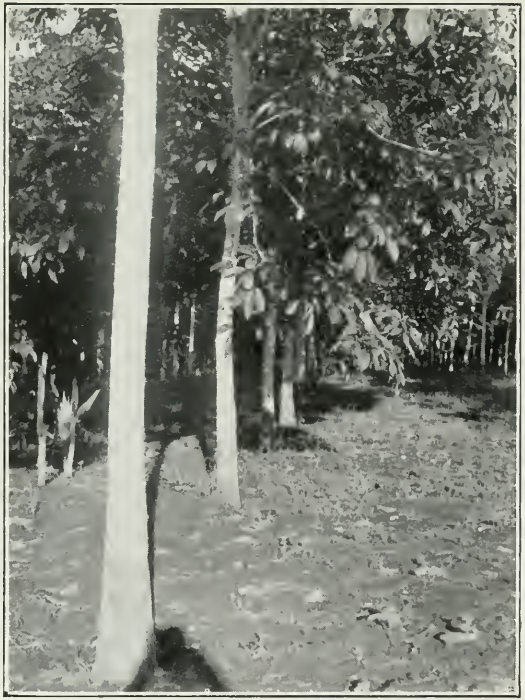
Of the various systems tested experimentally at the Botanic Gardens, Entebbe, the full and half herring-bone gave the best results, and the conductor of the experiments stated in his report that he would hesitate to recommend any other system. He inclined to the half herring-bone in preference to the full herring-bone for young trees, giving as his reason the improbability of young trees being able to stand the full herring-bone. This con-

clusion we do not agree with, for the area tapped by the herring-bone need not exceed that tapped by the half herring-bone. The test of severity in tapping is the area tapped, and the quantity of bark excised. The most important point for the planter to bear in mind is that every tapping takes from the tree a certain amount of bark, and that he must so regulate the rate of this removal, that the period is sufficiently long to allow of new bark being made as fast as the old is removed.

To ensure this, the tree should be worked systematically. It should be divided into one-third or one-quarter vertical sections, and each section should be made to last a year. This will allow each area three or four years to perfect its renewed bark before it is again required for tapping. For the growth of the tree, a four years' interval would be better than the shorter period, but which system will ultimately result in most Rubber being obtained over a long period is unknown. The tendency nowadays is to lengthen the period for bark renewal.

From the figures given on page 24 it will be noted that in all the Entebbe experiments tapping to 6 ft. was carried out. In the Kivuvu experi-

Herring-bone tapping to 6 ft. Botanic Gardens, Entebbe



Basal V tapping. Kivuvu

ment, tapping to 1½ ft. only was done. The removal of bark was, with the Entebbe trees, four times as rapid as at Kivuvu, but it will be seen that only in one instance did the yield approach the yield per unit of bark of the Kivuvu trees. This was in the case of the eight-year-old tree, and it is just where one would expect tapping to 6 ft. could be profitably carried out. There is little doubt that the tapping of such young trees to a height of 6 ft. causes an extravagant expenditure of bark for which no compensatory return in Rubber is secured.

For young trees five years old we favour only the basal V-system of tapping. The V should extend only across the section of the tree which has been decided upon, *i.e.*, one-third or one-quarter of the circumference. The base of the V should be 18 ins. from the ground. The slopes of the sides will form an angle of 45°. As the tree increases in girth, a second V can be added, 12 ins. above the first, and the two joined together by a vertical channel, so that the latex can be collected in one cup.

The manner of making the opening cut is rather important, and this work ought to be entrusted

only to skilled men. Care should be taken to get the angle of the sides of the V correct, and to secure that they do not extend beyond the area meant for them. From the point of the V, a vertical channel a few inches long should be made, and in this a small piece of tin placed so as to catch the latex in its downward flow, and run it into the cup placed underneath. The tin spout may remain always in position. The vertical channel is only a conducting channel, and is not again opened.

The opening cut made, it remains only to pare the lower side of the diagonal cuts at regular intervals. The work must be carefully watched. Tapping must be deep enough, or no latex will be obtained, but it must be only *to* the cambium, and not *into* that most delicate tissue. The thickness of the parings should be noticed, and the tappers taught only to remove the merest shaving of bark each time. In time, with paring the lower edge of the cut, all the bark down to the ground or the cut beneath it will be removed. The object of dividing the tree into sections is to ensure that the entire removal takes at least three years. If each section can be made to last even longer than a year, so

much the better. The flow will be as great on removal of a thin shaving as if a thick one be taken.

A great deal remains to be discovered as to the best interval to allow between each paring. Recent experiments in Ceylon point to the probability of equal results being obtained from weekly parings and from alternate day tappings. Should this prove to be a fact, it will, besides considerably lessening the cost of the Rubber, result in an enormous saving of bark to the trees. The system we ourselves have found satisfactory is alternate day tappings.

The opening cut produces no Rubber at all, and the cups need not be placed. At the second tapping, a small amount of latex will be seen to flow, and the amount will increase with each tapping, until in about a month after commencing the maximum is reached. This peculiarity of the Para tree of yielding only to persistent tapping is known as wound response. Different trees respond differently, and if it is found that individual trees are not yielding, the paring should be persisted in, unless, of course, some reason is obvious. Our trees at Kivuvu kept up the maxi-

mum flow for five months, when tapping was stopped solely because of dry weather. There was then no diminution in the daily yield of Rubber; quite the contrary, in fact, the last month's yield being the greatest obtained.

The tapper should be provided with plenty of cups, and be taught to pick them up systematically, He should tap and put down his cups until all are finished, when he should gather and empty those placed first. No cup should be lifted until the latex has ceased to flow. A remarkable divergence in this respect will be found amongst the trees. The tapper ought to be provided with a clean bucket containing a little water, into which to empty his cups. The water will prevent the coagulation of the latex before it reaches the factory. He should also be given a second bucket in which to put the bark shavings. Quite an appreciable amount of Rubber may be obtained by macerating this bark. By this plan also any latex remaining on the wound and coagulating is secured. When the tapper has finished all his trees, he should hand in his latex and shavings, and then clean up all his cups, so as to have them ready for the next morning. This is a good time

to take note of the thickness of each man's parings. He should be made to turn them out and exhibit them daily, and in this way careless work can be readily noted.

Tapping should commence as early as possible in the morning and be finished by 10 a.m. on a bright day. Should the morning be rainy, the work can commence as soon as the rain is over, and be completed as early as possible. The flow of the latex will be found to be considerably affected by sunshine.

Each tapper can deal with 500 trees. This gives him 250 to tap each day alternately. Each man should be given his own area, with which no other tapper should be allowed to interfere, except in the case of absence of the regular man. In this way, the men will know that bad work can always be brought home to them, and pride in good work will be encouraged amongst them. No system of pay by results in latex is advisable. It would only result in watering the latex or deep cutting of the trees. Frequent supervision to see that no trees are missed, and that no careless work is done, is the surest means of securing the best results.

Curing and Drying.—The latex immediately

after arrival at the factory should be strained to remove any bark or pieces of coagulated Rubber. It is then ready for coagulation. The system we adopt is to coagulate in troughs. By this means we get a coagulum which is convenient in shape for feeding the crepeing machine and being turned into Sheet Rubber. The troughs are 3 ft. long, 6 ins. wide, and 6 ins. deep.

A bucketful of cold water, to which has been added a few drops of acetic acid, is first put into the trough, and the latex is then added and stirred. The trough is afterwards covered over and allowed to stand until coagulation is complete. This, with us, takes a few hours, but the process can be hastened to any extent by the use of more acid, or by substituting hot for cold water.

Coagulation takes place through the Rubber separating from the water and forming on the top, as cream does on milk. The process is complete when the liquor under the Rubber is perfectly clear. The coagulum is then put through the crepeing machine two or three times, and is ready for drying.

In crepeing the Rubber, care must be taken to feed the rollers regularly, and to put but little

pressure on at first, increasing it the second and third times. In this way sheets of uniform width and thickness may be obtained.

The bark parings are also dealt with by the crepeing machine. Full pressure is put on, and the machine fed with the bark, a full stream of water running over it at the same time. The rollers crush the bark, and the water washes away the particles, while the strands of Rubber hang together. The mass is put through the machine time after time until sufficiently free of bark. It is then spread out to dry. When partly dry, if put again through the rollers, it is made into tough sheets, and has a very presentable appearance.

Drying should take place in a darkened room. The long sheets of Rubber are easily hung over rods, and take up little space. Natural drying takes two months. Where production is sufficiently large, artificial drying is practised, but as it will be several years before this stage is reached in Uganda, this method of drying need not be discussed here.

Smoking is practised to a large extent with plantation Para, but there appears to be no certain advantage in treating it thus. At one Rubber

sale, smoked Rubber may be in demand, and fetch a slightly higher price than Rubber that has not been smoked. At the next sale, there may be no difference between them. The operation of smoking is easily carried out by forcing smoke through the drying room.

Packing.—The packing of Rubber must be attended to with some care. Great stress is laid by Brokers on the need of properly grading the product. Grading should be according to colour, cleanliness and size of sheets. Each case should contain Rubber as even throughout as possible. Boxes should be used for packing, and these should be well made, and planed inside and outside. The sheets should be cut to fit inside the box without doubling, and be regularly packed. Pressure will be necessary to get the Rubber into a reasonable compass. No packing material of any kind must be used. Hoop iron should be nailed round each box to secure it. A case should contain not less than 100 lbs. nett. Each case should be numbered and its contents duly listed and sent to the Broker with the shipping documents. The larger the sample of each grade sent, the better the prices which may be expected.

CHAPTER XIII.

Collection and Preparation of Cocoa

Picking.—The picking of Cocoa involves little labour compared with the amount involved in Coffee picking, but more skill is required for the former kind of labour than for the latter. It is not an easy matter in the case of many of the varieties to tell just when a Cocoa pod is ripe. Some varieties change colour in ripening, others do not.

The pods must not be gathered before they have become ripe, or a bad sample of Cocoa will result. If left on the tree too long the beans will germinate inside the pod, and a mass of roots will be found on opening it. The Cocoa bean has a most inconvenient habit of germinating or dying when it reaches the full state of ripeness. Picking must therefore be regularly attended to in the ripening season. We have found that picking once a week ensures that there will be no loss from over-

ripe pods. In Ceylon tapping the pods as a test for ripeness is practised, a ripe pod being supposed to give a hollow sound. Our Buganda natives profess to be able to tell a ripe pod by its scent. We have never been able to detect any difference in scent between ripe and unripe pods, but we are bound to admit we have often seen a native detect a ripe pod, which by its appearance we would have declared unripe. These methods are, however, of little importance, as they cannot be adopted for the many pods which are out of reach; and as the bulk of the crop will be produced at such a height, the only practicable way of judging is by colour and appearance.

As explained elsewhere, the flowers of the Cocoa tree are produced in indefinite bunches, or, as Hart more clearly describes it, on cushions. The short thick stalk on the Cocoa pod is hard and woody, with no point of articulation, and cannot be pulled or twisted off without damaging the flowering cushion from which it arises. It must, therefore, be cut off with a sharp knife. It should be severed close to the pod to avoid the possibility of destroying other pods or flowers.

For picking pods beyond the reach of the hand

an implement known as a Cocoa-picker is used. It consists of a curved blade, similar to the point of a bill-hook, on a long handle. The inside of the curve is the cutting edge. Obviously considerable care is necessary in using such a tool to avoid dragging off the pod or injuring the bark of the tree. The pods may be allowed to fall to the ground on being severed. There are several modifications of the Cocoa-picker mentioned, and these are figured and described in " Cacao " by Hart of Trinidad. The pods should be gathered up from under the trees and taken to a central place for *shelling*.

Shelling.—This work is not a long process, and is carried out by hand. The pods are easily broken by giving them a sharp blow with a piece of wood. They should not be cut open, as there is a danger of some of the beans being cut. The whole of the contents is readily removed in one piece if the pod is ripe. If unripe it should be discarded. The placenta or central tissue on which the beans are growing should not be picked out at this stage, as it will be found of great help in assisting fermentation. It should be picked out when washing or drying the beans. The empty

pods should be destroyed by burning in order that they may not afford material for the growth of fungus diseases.

Fermenting and Drying.—It is in this process that the value of the Cocoa is decided. Fermentation is responsible for all the points desired by the buyer, such as break, colour, aroma, and flavour.

A good break may be described as the antithesis of a cheesy feel when the bean is crushed or broken. The colour desired is a light cinnamon. A Cocoa with a bitter flavour is of inferior quality. It may, perhaps, be of some help to describe the preparation of the sample of which the broker's report appears on page 31, and which it will be noted was described as very good in appearance and well prepared and cured. The fracture or break was said to be good, but the colour was considered too dark. The sample was prepared in the following manner :—

The beans after shelling were well mixed up and placed in a box lined with fresh banana leaves. More leaves were placed on the top and weighted with stones. The sample being a small one, overheating was impossible, and the beans remained undisturbed for 36 hours. The box was then

opened up, and the beans thoroughly stirred and then allowed to sweat for a further period of 36 hours. They were next removed from the box, thoroughly washed, and allowed to dry slightly for an hour on a tray, being then heaped on the tray without covering. For the next two days an hour's drying each day was given, followed by heaping as before, and the following day full sunshine for all day was allowed. This was continued until drying was completed.

In Ceylon a similar method of preparation, *i.e.*, sweating and washing, is followed, but in Trinidad Cocoa is not washed.

In Trinidad, after sweating, the Cocoa beans are laid a few inches thick on a wooden floor, exposed to the sun, and constantly stirred by men walking through them and shifting them with their feet. The fermented pulp or mucilage on the beans gradually dries, and when it reaches the sticky and almost dry stage, the beans are thrown into heaps, and handfuls of finely powdered red clay are scattered over them. This is known as "claying" the Cocoa.

While the clay is being scattered men are employed in treading or dancing on the heaps,

a process known as "dancing" the Cocoa. "Dancing" is continued until all the beans have a fine even coating of the clay. They are then heaped for the day. This operation is again commenced next day and continued until the beans show a polished surface. Trinidad Cocoa has been prepared in this way for many years, and the results of this method of curing are known to the market, and expected of Trinidad Cocoa. In Uganda we possibly could not follow out the West Indian method of preparation if we wished to, and we are not advised to follow it. We are advised to turn our attention to the production of washed Cocoa.

The proper time to allow for fermentation we have yet to discover by experiment. "In Trinidad the time varies from four to ten days with different kinds of Cocoa. The process is complete when the testa or skin of the bean has assumed a brown colour, and when on cutting the bean in halves the cotyledons are found separated, and all the cavities of the bean are occupied by the vinous liquor of the pulp which has passed through the testa during fermentation."*

*"Cacao," by Hart, of Trinidad.

When large samples are being prepared fermentation may generate too great a heat, and in such a case the sweating boxes must be opened out, and the Cocoa stirred. The temperature in sweating must not exceed 120° F.

Cocoa will dry in the sun in half the time required by Coffee. Artificial drying can be practised, and for this purpose the Coffee drier is suitable. The newly-washed Cocoa must not, however, be put into the machine, but the first stages of drying must be slow and natural, the machine being used for finishing off.

Grading.—The Cocoa should be graded before being packed. A machine similar to a Coffee grader is used. A small one worked by hand will deal with a large quantity of Cocoa. Four grades are made.

Packing.—Cocoa is shipped in bags. There are no regulations in East Africa enforcing the use of double bags as in the case of Coffee.

CHAPTER XIV.

Estate Management

For the success of a plantation, efficient and intelligent management are an absolute necessity. Any attempt to reduce management expenses by allowing only ill-paid or insufficient supervision is false economy, which will result in more or less pronounced failure.

The minimum size of a plantation for European supervision should be 250 acres. With less than this the management expenses, with a highly-trained manager, will be unduly high. Beyond this, we consider that an assistant is required for every additional 250 acres of cultivation. Where the estate is of 1,000 acres in extent, the staff should be not less than one assistant for every 250 acres, with a manager in addition.

Organisation of Staff.—It will be found best to portion out the fields on the estate amongst the assistants so that each shall always have the same

Estate Labour

charge and be responsible for all operations in it. He should, as far as possible, have always the same head men and gangs of natives. On a small estate the manager would also be able to take his share of this work, but on a large estate, where there are several assistants, and considerable office and administrative work, the whole of the field work should be portioned out amongst the assistants. In this way the manager will be free to leave the estate on business without any disorganisation of the work, and will be able to give his time to general supervision, and to any special work which may be in progress.

System of Allotting and Checking Work.—This will be practically the only work of the European assistants. It is the most important work on the estate, and the efficiency with which it is carried out will determine the measure of success of the estate. It is necessary to see that each native does his proper amount of work for the day, and does it in the proper manner.

In Uganda, most of the work on plantations is done as task-work. The coolie's task is set out in the morning, and he is at liberty to finish it at any time during the day, and then to leave. This

system relieves the supervisor of much work, and is well liked by the native. The setting of the task should be done in the early morning, and the work should be inspected once or twice whilst in progress, and again when finished before the day's work is marked up to the coolie's credit. It saves a great deal of bother to have all tasks standardised, and to stick to them, even although it may sometimes mean a light day's work for the men. We have found that the natives are willing to do a very stiff task occasionally, if they are assured that when the work is lighter the task will not be increased.

Measurement of such work as cutting bush and grass, and felling trees, is difficult, but even here it is best to give a gang of men a certain area to finish as a day's work. It is far better that the men should work with the completion of the task as an objective than that they should be just working for drum-beat. Planting, upkeep of nurseries, and certain weeding which is particularised in another chapter, should be done as day work only, with more constant supervision.

Office Records.—Besides the ordinary cash-books usually kept in any office, the estate office

should keep the following books: Roll-book, Allocation-book, Planting Records, and Crop-book.

Roll-book.—This will contain the names or numbers of all the labourers, with columns for entering daily whether present at work or not. A specimen page of a convenient Roll-book is given (page 134). This should be filled up at the end of the month with the total number of day's work, rate of pay, pay due, etc., and from this the men can be paid.

Each man should have a labour ticket, which should be marked up daily to correspond with the Roll-book. The man then knows what wage he is earning, and argument at the month's end as to the number of days' work is saved? The man gives up his ticket on receiving pay.

Allocation-book.—In this book is entered up daily the number of men engaged on every particular kind of work; and the daily total here should agree with the daily total of the Roll-book. At the month's end the total sum paid out as wages is divided up by the total number of days to get the average cost of a day's work, and from this the actual cost of each kind of work for the

Specimen Page of Roll Book

Month *19*

No. of Ticket	Name	Rank	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	Total Days Work'd	Rate of Pay	Pay Earned	Advances Recvd.	Nett Pay Due

Specimen Page of Labour Allocation Book

Month *19*

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	Total Days	Cost
New Areas.																																	
Clearing New Land																																	
Roads and Drains																																	
Lining, Holing and Planting ...																																	
Nurseries																																	
Weeding																																	
Buildings																																	
Coffee.																																	
Weeding Area in full bearing ...																																	
,, ,, ,, partial ,, ...																																	
,, ,, not bearing ...																																	
Upkeep, Pruning, Pests, etc. ...																																	
Collection and Preparation of Crop																																	
Packing and Transport of Crop ...																																	
Upkeep, Roads and Drains ...																																	
Rubber.																																	
Weeding Area in full bearing ...																																	
,, ,, ,, partial ,, ...																																	
,, ,, not bearing ...																																	
Upkeep, Pests, etc.																																	
Collection and Preparation of Crop																																	
Packing and Transport of Crop ...																																	
Upkeep, Roads and Drains ...																																	
Cocoa.																																	
Weeding Area in full bearing ...																																	
,, ,, ,, partial ,,																																	
,, ,, ,, not bearing ...																																	
Upkeep, Pruning, Pests, etc. ...																																	
Collection and Preparation of Crop																																	
Packing and Transport of Crop ...																																	
Upkeep, Roads and Drains ...																																	
Total ...																																	

month can be worked out. A specimen page of this book suitable for an estate in Uganda is given (page 135).

Planting Records.—All planting operations should be recorded here. The entry should give the date and the number and the kind of plant put out, with a note to locate the field in which the work was done.

Crop-book.—Daily entries should be made during the crop season in this book. The weight of Coffee berries and wet Rubber should be entered up in pounds. The number of Cocoa pods gathered should be recorded. From these figures, fairly accurate estimates of the month's crops can be obtained for the monthly returns, without need of waiting until the crop is fully prepared. It is also possible to discover any leakage by theft or loss from the factory, if check is kept of the raw material which is gathered, and the amount of finished product is compared with it.

Estate Returns.—Where returns have to be submitted to a head office, or on any estate where work, costs and returns are properly checked, it is necessary to make out a monthly return on a special form. Such a form containing columns to

fill in all the necessary information is given at the end of the volume.

It will be noted that all the expenditure has to go into either the capital or revenue expenditure columns. Capital expenditure is all the costs of the estate, or part of estate, until it reaches the bearing stage. The portions which will produce during the year should therefore have all their expenditure during that year entered up as revenue expenditure, and these costs will go against the return from crops. Buildings and machinery would, of course, be bought out of capital.

CHAPTER XV.

Cost of Establishing Plantations and of Preparing Products

Capital Costs.—There is great difficulty in giving any definite figures of costs owing to the rapidly-changing conditions in Uganda. Land is going up in price by leaps and bounds. What could have been bought for 5s. per acre five years ago now commands a price of £5 per acre. Labour, too, is tending to become more costly. Most certainly the progress which is expected to take place in the next few years will result in very much higher wages than are now given. There will, of course, be also an increase in the efficiency of the labour; and it is to the advantage of everyone, not excluding the native, to keep the wages as low as possible, and to allow increases to be only very gradual, keeping pace with the increased efficiency.

Management is also a factor which may upset any calculations. The costs of all the various

operations may very easily be doubled by faulty management. The work can be economically carried out only by the manager and his overseers having the necessary technical knowledge and familiarity with local conditions, and applying the knowledge conscientiously and without any outside interference.

Leaving aside the cost of acquiring the land, we estimate the capital costs of bringing the various crops to the bearing stage to be as follows :—

Coffee only, per 100 acres,	...	£1,500
Coffee and Para, interplanted,		£1,500
Para only, per 100 acres,	...	£2,000
Cocoa only, per 100 acres,	...	£2,000

These figures cover clearing, planting, upkeep, management, buildings, and machinery. It must be understood that to work within them, an estate of at least 500 acres must be planted. If less than this area is cultivated, management, buildings, and machinery will cost proportionately more per 100 acres.

Costs of preparation of Crops.—The remarks made above with regard to management and cost of labour naturally apply here also. We estimate

the cost of putting the various products on the market to be as follows :—

Coffee, per cwt.	25/-
Cocoa, per cwt.	25/-
Rubber, per lb.	1/-

This should cover all revenue charges against the estate, such as upkeep, collection, preparation, freight, and sale charges.

LONDON CHARGES ON COFFEE.

LONDON CLEANED.

A 10-ton Consignment in Parchment.

	£	s	d
Marine Insurance, £600 ...	4	18	1
Fire Insurance, £600, ...	0	7	6
Husking, Polishing, Grading, Landing, Rent, Delivery, Samples ...	34	14	11
Port Rates	0	6	10
Sale Expenses, Brokerage, etc. ...	17	5	0
	£57	12	4
Less allowance on Empty Bags, ...	1	1	3
Nett,	£56	11	1

10 tons uncleaned equals 8 tons cleaned,

Nett charges per ton	£7	1	5

UGANDA CLEANED.

A 2-ton Consignment.

	£	s	d
Port Dues	0	1	5
Marine Insurance	0	12	6
Fire Insurance	0	1	11
Landing, Delivery, Rent, Samples ...	1	15	2
Sale Expenses, Brokerage, etc. ...	4	8	2
	£6	19	2
Nett Charges per ton	£3	9	7

CHAPTER XVI.

Insect Pests and their Control

So far, our crops have suffered very little from attacks of insects. We have, however, with us several insects which are capable of doing serious damage should they become sufficiently numerous, as they probably will in the future, with large tracts of country under the cultivation of similar crops. Scale insects have appeared on our Coffee and Cocoa. Fruit flies have also appeared on both crops. The Coffee berry-beetle has caused some damage. Green fly are sometimes a nuisance on the young growths of Cocoa. Nocturnal crickets are on many estates particularly numerous, and cause much damage in the nurseries and to newly planted fields. White ants are present almost everywhere.

The trained cultivator knows from experience that one of the surest means of guarding against insect attacks is to keep the trees in vigorous

health, by practising good cultivation. Healthy plants seem capable, by their own vigour, of keeping off injurious insects; and it will generally be found that an attack has been preceded by some check to growth which lowers the condition of the plant. It is claimed that even the white ant will not attack a completely healthy plant. Good and clean cultivation should therefore be always maintained, and on an infested field, attention to cultivation should be given simultaneously with treatment to the trees.

It will be seen that our list of insect enemies is not a lengthy one, and that Rubber has practically none.

On the staff of the Agricultural Department, a qualified Entomologist has been working for some years; and "An Account of Insects injurious to Economic Products," published by him last year, and detailing the experience he has gained, is of great service to planters.

The Uganda Planters' Association have imported a large quantity of insecticides and apparatus, and propose to keep in the country a stock sufficiently large to deal with any outbreak.

Stringent regulations against the importation

of plants and seeds from certain countries, and providing for compulsory treatment in all cases are now in force. It is hoped that by this means Uganda may escape the experiences of other countries, where the most serious pests have been found to be those introduced from abroad. The Government have appointed a Plants Pest Board, composed of members of the Agricultural Department, representatives of the Planters' Association, and of the native community. This Board has the power of life and death over any plantation, and can compel any necessary treatment to be given.

With all these precautions, there seems little danger of any serious outbreak. Uganda is a new country, starting with practically a clean sheet, and with the advantage of all the accumulated experience of other countries at hand. We are now practising every precaution which all that experience suggests, and can only leave the result to the future, content that we have done our best.

Scale Insects.—These insects have been noticed as more prevalent in a dry than in a moist season, and also as most frequently attacking young trees, both Coffee and Cocoa. This bears out the remarks made above as to the capacity of vigorously-grow-

ing trees to ward off attacks. Young trees are naturally less robust than older ones, and the dry season is the period when vigour is at its lowest ebb. We have, however, become so accustomed to see young Coffee here and there becoming infested by scale in the dry season, and to see the scale disappear from it again in the rains, that we regard its appearance with equanimity.

More noticeable than the scale itself is a black fungus which grows on the excreta. This covers the leaves of a badly infested tree, and will greatly hinder growth if allowed to remain for any time. The fungus is known as "Black Blight" or "Sooty Mould."

An effective spraying mixture is made by using 1 lb. of whale oil soap in 6 gallons of water. For the scale on Cocoa pods, Mr. Gowdey found this mixture, used at double strength, at 10 day intervals, moderately successful.

A resin wash calculated to destroy scale by asphyxiation is made as follows :—

Resin, 4 lbs.; Seal oil, 2 pints; Caustic Soda, $1\frac{1}{2}$ lbs.; water, 10 gallons. Boil until the resin is dissolved, then make up to 15 gallons of water. To use, allow 1 gallon of above stock solution to 8

gallons of water. This wash is much used in America, against scale. It would be harmless to Coffee trees. It should be very cautiously used on Cocoa leaves.

A spray we have used with good effect on Coffee attacked with scale is a kerosene emulsion, made as follows :—Dissolve 1 lb. of soft soap in a gallon of boiling water. Add slowly, whilst continually stirring, 1 gallon of kerosene. The mixture should then be thoroughly churned with a syringe until an emulsion is formed. For spraying, dilute with water, using ten parts of the latter to one of the mixture. The spraying should always be done in the early morning.

We think it right to say that we should hesitate very much about recommending the use of this mixture for Cocoa. Cocoa leaves being soft and tender, are easily damaged by strong insecticides. The leaves of Coffee will stand very strong mixtures.

Fruit Flies.—Several species of these attack both Coffee and Cocoa. But we have so far observed only the Coffee fly. The eggs are laid by the fly under the skin of ripening fruits. The larvae, when hatched, burrow into the fruit, and feed on

the sweet pulp surrounding the seeds. Fortunately, by the time the pulp is sweet and palatable to the grub, development of the seed is practically complete, so that little damage can be done. These insects would be a serious pest where the product was a fruit, but as, with us, it is only the seed which is of value, disfigurement of the fruit is of minor importance.

The larvae in the pulp are destroyed in the ordinary process of fermentation, both of Coffee and Cocoa. If the recommendations we make regarding the gathering up of all fallen Coffee berries when a tree has been picked, be carried out, very few of the maggots will escape the fermentation process.

Coffee Berry Beetle.—This is the most serious pest which has so far troubled the Coffee planter in Uganda. The eggs are laid at the point of the half-formed berry, and the grubs, as soon as hatched, begin to burrow into the berry. They there mature, and then bore another passage out. Very little can be done to control the pest, except to pick off and destroy infested berries. Of course, if this measure is adopted, the destruction of the berries must take place whilst the insect is inside

them. It is not so easy to tell exactly when this should be done, as the point of entry is not very readily discovered. The hole made by the insect in emergency is much larger and more easily seen. Generally only one bean in the berry is affected by the grub, and the machinery used in the preparation of the Coffee picks out beans so affected, so that an infested crop suffers only in quantity, not in quality. It is our belief that this pest will not prove continuously abundant, but will be common in some years, and scarce in others. We know of an estate where it caused considerable alarm some years ago, and from which it has entirely disappeared since. We have noticed that shaded Coffee is more susceptible to attack than unshaded. In fact, we have seen unshaded Coffee entirely escape, whilst a few yards away, shaded trees were badly infested. It would be of great interest to learn if the beetle is a shade-loving insect.

Green Fly, or Aphis.—This pest occasionally attacks the growing shoots of Cocoa. Spraying with whale oil soap solution is an effective remedy.

Nocturnal Crickets.—The habit of these insects is to cut off young plants close to the ground, and carry off the young leaves to their burrow in the

earth. In some places they are particularly numerous, and we have known of instances where 20 per cent. of young plantings have been destroyed by them. A few insects will cause grave damage in a nursery.

They can be easily caught at night if searched for with a light. The offer of a small reward for all insects brought in by the labourers will result in the destruction of large numbers.

Mealy Bug.—This pest is present in the country, but not to any great extent. It is a small insect covered with a white cottony web. It is allied to the Aphids, and similar remedies will control it.

White Ants.—These insects are very numerous in Uganda. They have so far not proved very destructive to our crops. Probably Rubber trees have suffered most, but healthy trees seem safe from attack. We often notice white ants climbing the stems of Para trees, and eating away any lichen or rough bark on them. They do not eat into the live bark. There is very little doubt that in most cases where damage has been done, the tree was previously injured in some other way.

The Ant-hills should be dug out all over the estate. The destruction of the Queen Ant usually

results in the abandonment of the nest by the others. For the destruction of White Ants or Termites, bisulphide of carbon is the most effective agent known. It is a clear, colourless liquid, with an offensive smell, and is highly inflammable, the vapour igniting even from a lighted cigarette. The fumes, when ignited, are highly poisonous. For these reasons, the substance requires to be dealt with by some one aware of its properties. A wine-glass full, or half full, according to the size of the nest, run into an ant's nest and then fired, should kill all the ants, if the escape of the fumes be prevented. This substance is also useful for destroying rats and various other vermin.

CHAPTER XVII.

Diseases caused by Fungi

By George Massee, F.L.S., V.M.H.

At the outset, it may be well to point out a few mistakes made by practical men, as to the particular way in which fungi do their work.

It is usual to hear the planter asserting, after the presence of the disease has become obvious, that up to a certain date the plants were quite healthy. This is generally a mistake. When the seed of any plant is sown, some considerable time is occupied in the formation of root, stem, leaves, etc., and in storing up food, before the fruit is produced. In a similar manner, when the spore of a fungus falls on a leaf, say a Coffee leaf, it germinates on the surface of the leaf. The sprout enters into the tissues, and there forms a quantity of spawn or mycelium, obtaining its food from the

leaf. In course of time, the leaf ceases to provide food for the fungus, and the latter then bursts through the skin of the leaf and bears on its surface a crop of spores, which are scattered by wind, birds, insects, etc., and infect other leaves. In reality the leaf was diseased from the moment the sprout of the spore entered its tissues, although sometimes weeks passed before there was any outward sign of the presence of the parasite in those tissues.

This statement is true of hundreds of kinds of fungi that are parasitic on plants both wild and cultivated; in fact, it is true of all parasitic fungi, with the exception of a few mildews, of which the Hop mildew and Rose mildew are examples. Such being the case, it is quite obvious that the only way to guard against infection from the spores of fungi is to prevent their entrance into the leaf, and spraying with a fungicide is the only known method of accomplishing this object. We are quite well aware of the many practical difficulties standing in the way of spraying in the tropics—torrential rains, nature of the ground, labour, etc., yet in very many instances spraying could be practised with decidedly beneficial results.

Spraying is not a curative measure, for the reason given above, that the growing portion of the fungus is in the tissues of the leaf, and cannot be reached by the fungicide. What spraying will do, if applied in time, is to prevent the first infection of leaves, by covering the surface with a substance poisonous to the germinating spores.

To accomplish this object the disease should be anticipated; in other words, spraying should commence before the disease appears. An experienced planter will know at what particular season of the year infection is most likely to occur. When a disease is present spraying will arrest its progress, by destroying the spores that alight on the surface of the foliage.

Bordeaux mixture is, perhaps, the best for spraying, and it can now be procured in the dry condition, ready for dissolving in water when required. As a rule, spraying is continued for too long a time. The moment the solution commences to drip from the foliage it is time to stop. Always commence with a solution containing more water than is prescribed in the directions given, and gradually decrease the amount of water until the leaves show injury. As some plants will bear a

stronger solution than others, experience will be the great guide in such matters.

So far, we have been dealing with those fungi which attack the foliage and above-ground parts of plants by means of spores. We now come to consider a second group, which have a different and far more damaging method of attack. To this second group belong those fungi whose spawn or mycelium live in the humus and travel long distances in search of new plant roots, when the tree they have already attacked is dying from their ravages, and no longer supplies the required amount of food. The fungus produces its fruit on some above-ground portion of the dying tree, so that the spores may be carried by various agencies and infect other trees.

Although the fungi belonging to this group can reproduce themselves by spores, yet the most serious injury they do is by means of their mycelium, which is usually in the form of white strands spreading in the ground in every direction a few inches below the surface. To this group belong the large bracket-like fungi, the large agarics, or toadstools, as well as many minute or microscopic kinds. Stumps left in the ground, as is well

known, are centres of infection from which mycelium spreads in the soil in every direction. The most effective means, therefore, of checking the spread of mycelium would be to remove all stumps. This, however, for various reasons cannot be done, at least not at once. As the strands of mycelium extend through the soil, growth takes place only at the tip, the back portion dying away. The tip or growing point consequently requires food at every stage of its progress. If such food is withheld it dies at once. This knowledge affords a means of checking the spread of mycelium in the soil by means of open trenches. Such trenches need not be more than a foot wide, and about a foot in depth. If an open trench of this description was made round every stump, the spread of mycelium from such infected centres would be practically arrested. Similar open trenches breaking up the entire portion planted into small areas would also go far towards checking the underground spread of fungi, which cause far more injury to cultivated plants in the virgin forest than is usually realised. Of course, as in the case of spraying, the difficulty of keeping open trenches in the tropics would be serious in many localities,

yet it is well to know how to apply the only practical remedy against ground fungi.

Almost invariably the first symptom shown by a plant whose root is attacked by a fungus, is a reduction in the amount of foliage, and also a more or less marked reduction in the size of the individual leaves which wilt and fall early and the tree dies. Of course, the time elapsing before a tree is killed by a root fungus varies according to the intensity of the attack. To make certain that a fungus is present in the root, or collar, remove a portion of bark from either of these parts, and the presence of mycelium, usually white in colour, proves that the injury is caused by a fungus. The mycelium of the fungus gradually spreads in the tissue of the root and collar, and ultimately chokes up the water-conducting system of the tree, thus but little water can ascend from the root into the leaves, which, therefore, wilt, and the plant is practically starved to death.

Coffee Leaf Disease

(*Hemileia vastatrix.*)

This too familiar disease, when once seen, cannot be mistaken for any other parasite on Coffee. The leaf is the part most frequently attacked, the fungus bursting through the skin under the form of deep orange, powdery patches which are composed of the spores, or reproductive bodies of the fungus. The spores are of two kinds and serve different purposes. The most numerous kind are capable of germinating and infecting a plant the moment they are mature, and it is owing to these spores that the disease spreads so rapidly when it has once gained a foothold. The second form of spore, which grows mixed with the more numerous kind, is known as a resting spore. It does not germinate at once, but remains attached to the leaf, which usually falls to the ground soon after the mass of spores has been shed. The resting spores, still attached to the fallen dead leaves, germinate in course of time, and set up a fresh wave of disease. The young shoots and berries are also some-

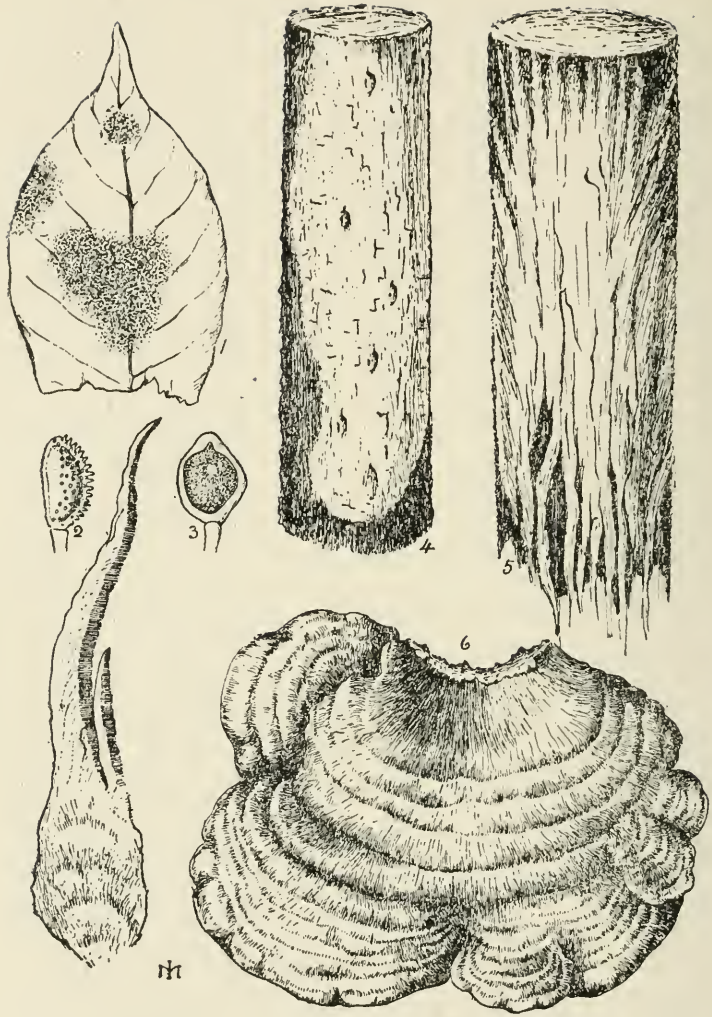


Fig. 1.—Portion of Coffee Leaf with clusters of *Hemileia vastatrix*, the Coffee leaf disease.

Fig. 2.—Summer spore of same that enables the disease to spread quickly.

Fig. 3.—Winter spore of same that starts the infection for the season.

Fig. 4.—*Corticium salmonicolor* on branch of Para Rubber.

Fig. 5.—Mycelium or spawn of *Fomes lignosus* on root of Para Rubber.

Fig. 6.—Fruit of *Fomes lignosus*.

Fig. 7.—Section of same.

times attacked by the fungus. Until recently the fungus was considered to be confined to *Coffea arabica* and *Coffea liberica*, but it has now been found on other kinds, such as *Coffea robusta*, and on certain so-called " wild " kinds of Coffee found in Africa. Unfortunately, up to the present, no means of keeping this parasite in check have been discovered. Spraying with Bordeaux mixture, where practicable, would be effective, but the spraying should be commenced before the appearance of the fungus on the leaves. In those districts where the fungus has been previously observed, the planters will know the proper time from experience. The danger arising from the presence of fallen diseased leaves must be kept in mind. It has been demonstrated that Coffee trees grown in the open are less susceptible to the disease than those grown in the shade.

Root Disease of Hevea (*Para Rubber*).

(*Fomes lignosus.*)

This fungus has hitherto been called *Fomes semitostus*, but it has recently transpired that a

single specimen of the same fungus in the Upsala herbarium had been previously named *Fomes lignosus*, and hence the latter name will have to be used in future. *Fomes auberianus* is another name that was given to the same fungus. This fungus is the most destructive to Hevea that the planter has to contend with, and its distribution is so wide within the tropics that but few plantations are likely to escape it. The root is the part attacked, and in the case of young trees, which suffer most, the presence of the fungus is not suspected, or seen, unless specially looked for, until the tree has been practically killed. The presence of white spawn, or mycelium, on the root is the indication that *Fomes* is attacking the tree. The mycelium usually takes the form of irregularly branching strands, which run out into feathery tips, closely attached to the bark. The mycelium gradually permeates the entire substance of the tap-root, softening it and making it a delicate morsel for white ants, by which it is often completely eaten away. The ants are often looked upon as the only cause of injury, but if the white mycelium is present, it may be taken for granted that the fungus was the primary cause. On the

other hand, white ants, in some instances, are known to attack the young trees, independently of the fungus. The fruit of the fungus is produced only on dead wood, and is rarely seen on Rubber plants, but is generally abundant on stumps of certain kinds of trees. These particular fungi are commonly known as bracket-fungi, because they grow out of the stump in the form of a flap or bracket, more or less approaching the semi-circular in shape. The upper surface is concentrically grooved, and its colour is yellowish-brown, with darker concentric bands; the edge, when the fungus is growing, is thickened and clear yellow in colour; the under-side is orange, but afterwards becomes reddish-brown, and it is covered all over with crowded minute holes. The fungus is two to four inches across, and rather thin. It often grows in over-lapping tiers, and when dry is hard and brittle.

The great amount of mischief done by this fungus in Rubber plantations is due to the spread of mycelium in the soil, from stumps infested with it. Obviously, the most certain remedy is to have all such centres of infection in the way of stumps removed. The next best course is to make a trench

round each stump, and if lime is procurable to work some into the soil round each stump. A preparation known as "Fungal" is excellent for this purpose, and could, with advantage, be worked into the soil throughout the plantation. Its effect on soil fungi is drastic. All fruits of the fungus appearing on stumps should be collected and burned, otherwise the spores are scattered far and wide, and start new centres of disease.

Black Blight

(*Asterina tenuissima.*)

This fungus, and allied kinds, form black patches, or stains, on the bark and fruit of Hevea. In some instances, there is a mere blackish stain; in others more or less velvety patches are present. These fungi are not parasitic; they live on the sugary secretion from the nectaries at the base of the leaf, or on the sugary secretions of various insects. Spraying with an insecticide would meet the case, but the fungus does no harm, and unless present in great quantity it is scarcely worth the trouble.

Brown Root Disease

(*Hymenochaete noxia.*)

The popular name, Brown Root Disease, given by Petch to the injury caused by this fungus, is quite appropriate.

The fungus was first noticed more than half a century ago, as being very destructive to Bread-fruit trees in Samoa. It is now known to occur in many tropical countries, and is probably widely distributed. Many kinds of economic trees are attacked by it, such as Coffee, Cocoa, *Hevea*, *Funtumia*, Tea, Camphor, and various forest trees.

As in the case of *Hevea*, the root is the part attacked by this fungus, and the symptoms of its presence are so very marked that it cannot be mistaken. The mycelium, or spawn, is brown, and at first forms a loose weft round the tap-root and its branches. This mycelium binds together the soil and stones into a compact incrusting mass, which finally becomes sheathed with a blackish felt of mycelium, and passes up the collar to a short distance above ground. The fruit of the fungus is

met with only on trees that have been dead for some considerable time, hence it is rarely to be seen in plantations; but the mass of earth and stones bound to the root by brown mycelium is an unfailing indication of the nature of the disease. The fruit forms a thin, inseparable layer round the base of the stem, of a deep orange-brown colour, changing to a dusky brown when the fruit is dead and dry. The surface is minutely velvety. A very fine specimen on Cocoa from the Gold Coast shows the fruit completely surrounding the stem for a length of nine inches, commencing at the collar, where the underground mycelium ends. This disease does not spread as quickly as that of *Fomes*, as the mycelium does not spread in the ground, but only travels along the spreading roots of diseased trees. It can, therefore, only infect another tree whose roots come in contact with those of the diseased tree.

Diseased trees should be dug out and the branches of the roots also removed, as far as practicable. The soil all round should be treated with quicklime or "Fungal."

Canker

(*Phytophthora faberi.*)

This parasite attacks both *Hevea* and Cocoa, causing injury to the stem and the pods in both instances. The fungus itself cannot be seen without the aid of a microscope. The external symptoms of its presence are not very obvious in *Hevea.* The ordinary indications of a canker are absent, the bark not being rough or cracked in any way. In fact, Petch states that a tree may be killed and all its bark decayed without showing any roughness or open wounds. The same author states that a sudden stoppage in the yield of latex often suggests the disease. Under these circumstances, if, when the outer layer of brown bark is scraped off, a black layer is seen, and the cortex below this is found to be discoloured, the presence of the disease may be taken as fully established. Diseased patches of bark should be removed at once, and the exposed wood protected by a coat of gas-tar, care being taken that the tar does not spread over the living bark. The fruit is also attacked, the symptoms being a water-logged,

blackish appearance. According to Petch, fruits that are attacked become shrivelled and split, and rot on the tree. The fruit suffers most in very wet seasons.

The same fungus also attacks the stem and fruit of Cacao, and indeed its distribution as a disease on this tree is far more general than has been recorded for *Hevea*. For this reason, it is not wise to grow the two mixed, as one plant will communicate it to the other, and thus the chances of loss are multiplied. Its presence on Cocoa amounts to a certainty.

Diseased fruit should be collected and burned. In the West Indies it was found that one source of infection, and the principal one in many plantations, was the accumulation of heaps of fruit husks, which were simply teeming with the *Phytophthora*.

Pink Fungus Disease

(*Corticium salmonicolor.*)

This fungus has other names, such as *Corticium javanicum*, *Corticium Zimmermannii*, etc. It attacks many different kinds of trees, including

Hevea Cacao, and Coffee. The fungus forms a thin film, not much thicker than a coat of paint, on the bark. When actively growing it is of a pink colour, but this changes to a dingy ochre later on; and the latter colour again gradually gives place to white as the very advanced stages of existence are being reached. The bark then becomes more or less cracked. It often originates in the fork of a tree, and gradually extends until it completely or almost completely encircles the trunk. The bark is killed, cracks and falls off, exposing the wood. When branches are ringed, the portion above the injury dies. The fungus is favoured in its development by moisture. If the patches are small, the bark should be removed, and the wound protected by a coat of tar. The disease is spread by spores carried by wind, and also probably by insects. Spraying the stems with Bordeaux mixture would prevent infection through these agencies.

CHAPTER XVIII.

Table of Distances for Planting

Trees per acre at various distances :—

Feet apart.	Sq. ft. per Plant.	Plants per Acre.
6 × 6	36	1210
6 × 7	42	1037
6 × 8	48	907
7 × 7	49	889
7 × 8	56	778
7 × 9	63	691
8 × 8	64	681
8 × 9	72	605
9 × 9	81	538
10 × 10	100	435
10 × 13	130	335
13 × 13	169	257
15 × 15	225	193
18 × 18	324	134
20 × 20	400	109
24 × 24	576	75

APPENDIX.

Percentages of Various Grades in Different Consignments by Weights

No.	Where cleaned.	How dried.	Pea-berry.	Bo'd.	Med'm.	Small.
1	Uganda	Sun	6·25	15·58	59·42	18·76
2	,,	,,	10·00	17·50	48·75	23·75
3	,,	,,	9·41	6·22	46·87	37·50
	Uganda cleaned	Sun dried, averages	8·55	13·10	51·68	26·66
4	London	Sun	6·00	56·00	20·00	18·00
5	,,	,,	4·73	17·83	33·33	44·11
6	,,	,,	3·13	26·56	35·94	34·37
	London cleaned	Sun dried, averages	4·62	33·46	29·76	32·16
7	London	Artificial	5·35	58·03	21·45	15·17
8	,,	,,	6·55	66·12	12·02	15·31
9	,,	,,	7·37	61·05	15·79	15·79
10	,,	,,	7·40	70·31	14·89	7·40
	London cleaned	Artificially dried, averages	6·67	63·88	16·04	13·42

These figures will repay close scrutiny. They show some very remarkable facts, which it will be important for the planter to bear in mind. We may add, the figures are from the actual sale lists.

If we take first the sun-dried Coffee, we find on comparison a very considerable difference in the percentages of the various grades between Uganda-cleaned and London-cleaned. The differ-

ence is, of course, due to the use of different meshes in grading. As explained elsewhere, the London cleaners are able to grade according to the demands of the market, and to increase the amount of any grade which happens to be particularly in demand, by the inclusion in it of what might on another occasion go into a different grade. What difference this may cause may be seen by comparing consignments Nos. 3 and 4. This Coffee was shipped together, and was identical. Half was cleaned in Uganda and half in London. The figures are sufficiently remarkable to bear repetition here :—

		Peaberry	Bold	Medium	Small
No. 3. Uganda cleaned	...	9·41	6·22	46·87	37·50
No. 4. London cleaned	...	6·00	56·00	20·00	18·00

The difference in price between Bold and Medium is about 3s. per cwt., so that the advantage in this consignment was enormously in favour of London grading.

More remarkable still are the figures relating to sun-dried and artificially-dried Coffee. Consignments Nos. 6 and 7 were sent together, and were precisely similar, excepting that one half was sun-

dried and the other machine-dried. The figures are as follows :—

	Peaberry	Bold	Medium	Small
No. 6. Sun dried	3·13	26·56	35·94	34·37
No. 7. Artificially dried ...	5·35	58·03	21·45	15·17

These figures show that artificial drying results in less shrinkage of the bean than sun-drying, and consequently a very large increase in the higher grades of the consignment. A glance at the tables will show how very regular the proportions are in the artificially-dried, as compared with the sun-dried, consignments. To take the Bold size for example, the sun-dried varies from 17 per cent. to 56 per cent.—a range of 39—whereas the artificially-dried varies only from 58 per cent. to 70 per cent.—a range of 12.

The averages of the tables compare as follows :

	Peaberry	Bold	Medium	Small
Uganda cleaned, Sun dried ...	8·55	13·10	51·68	26·66
London „ Sun dried ...	4·62	33·46	29·76	32·16
„ „ Artificially dried	6·67	63·88	16·04	13·42

NOTE.—The Peaberry in Uganda-cleaned contains a certain percentage of Bold. To separate very large Flats and Peaberry, a special machine is used in London. Hence the smaller percentage of Peaberry shown in London-cleaned.

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Estate **ESTATE MONTHLY RETURN** *Report for Month of* *19*

No. of Analysis	PARTICULARS OF EXPENDITURE.	Rs.	Cts.
	TOTAL CHECK ROLL—		
	Less Lent Labour		
	Manager's Salary		